ILLUMINATING ENGINEERING

JANUARY, 1949

Architecture, Light and Color in a Shoe Shop
Economics of Store Lighting
Characteristics of Louver and Louverall Systems
Lighting Progress Report For 1947-1948
Is Lighting Application a Lighting Problem
Light Sources and Colored Objects

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

the NEW Trend in lighting!

LOUVERALL LIGHTING WITH LUMINOUS VINYLITE LOUVERS CREATES A NEW EXPERIENCE IN SEEING!

The trend not only is unmistakably to louvered ceilings of light . . . but to ceilings with LUMINOUS LOUVERS!

When you experience the lighting effect achieved with luminous louvers it's not hard to understand why those who *see* it, so overwhelmingly *prefer* it!

The secret of "Sky-Glo's" superiority is in its exclusive Vinylite (plastic) louvers which not only reflect light but also transmit light.* Thus "Sky-Glo" provides a translucent ceiling that not only affords a means of obtaining more light without annoying glare but actually offers a new experience in seeing!

"Sky-Glo" makes possible these high levels of illumination (in range of 50 to 150 footcandles) with exceptional low brightness (less than 1 footcandle per sq. in.). The result: a soft glareless illumination that makes seeing easy; that creates a restful yet stimulating atmosphere; that makes one completely unaware, visually and psychologically, of the high levels of illumination that are responsible for this "new experience in seeing."

Translucent "Sky-Glo" louvers heighten the beauty of the ceiling and add a scintillating and harmonizing note to the entire decorative scheme. Add to these exclusive advantages of "Sky-Glo" all of the many conventional advantages of the louverall lighting system and you can see why the new trend in lighting is so definitely to Benjamin "Sky-Glo."

BENJAMIN ELECTRIC MFG. CO., Dept. I, Des Plaines, Illinois

*Reflection Factor is 18%.
Transmission Factor is 71%.

Illustration above—the reception room of Cluett, Peabody and Company, Inc., 75 E. 40th Street, New York, N. Y. Designed by Robert Heller, Industrial Designer, New York City.

Illustration left—Wright Clothing Store, Greensboro, N. C. Designer and Contractor: Starr Electric Co., Greensboro, N. C.

Lower left illustration—Main Banking Area, Central Trust Company, Rochester, N. Y., Consulting Architect, A. G. Alexander, New York City.

"Sky-Glo" Lighting Manual Available FREE to Illuminating Engineers

For complete story and data on one of the most significant developments in fluorescent lighting history in terms of lighting performance, applications, modernization and maintenance, write for your complimentary copy of Bulletin "SG."

BENJAMIN TRADE MARK

"Sky-Glo"

LUMINOUS LOUVERED LIGHTING SYSTEM

Distributed Exclusively Through Electrical Wholesalers

R-3124-S

Safe Street Lighting Pays

—IN CANCELLED ACCIDENTS

The cost of traffic accidents is the largest item in street maintenance. The economic waste from automobile accidents in this country exceeds $1,250,000,000 annually . . . and 60% of the traffic fatalities occur at night.

How can we handcuff America's No. 1 public killer and cancel a large percentage of these accidents? The answer is *planned street and highway lighting.* It is estimated that for $2.40 per capita an adequate Traffic Safety Lighting Program can be inaugurated.

Call your local Westinghouse Distributor for information about street lighting. *A Westinghouse Sales Engineer will gladly co-operate with you and your electrical contractor in the development of a plan.*

J-04205

YOU CAN BE SURE IF IT'S Westinghouse

THE NEW
OV-20
New, high-efficiency mercury lamps provide higher light intensities per dollar invested. The entirely new optical system gives more effective light control than conventional mercury luminaires.

COMMERCIAL • INDUSTRIAL • FLOOD • STREET • AVIATION

Westinghouse Planned Lighting *Pays*

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

CHARTER ADVERTISERS

IN

ILLUMINATING ENGINEERING

Acme Electric Corporation
Addison-Wesley Press Incorporated
Benjamin Electric Manufacturing Company
Certified Ballast Manufacturers
Certified Starter Manufacturers
The Chatfield-Clarke Company
Colonial Electric Products Incorporated
Corning Glass Works
Curtis Lighting Incorporated
Day-Brite Lighting Incorporated
Electro Manufacturing Company
Ender Manufacturing Company
Fluer-O-Lier Manufacturers
The Frink Corporation
Garden City Plating & Manufacturing Company
General Electric Company, Apparatus Dept.
General Electric Company, Construction Materials Dept.
General Electric Company, Lamp Dept.
Gill Glass and Fixture Company
Graybar Electric Company Incorporated
The Edwin F. Guth Company
Holdenline Company
Holophane Company Incorporated
International Lighting Exposition
Kopp Glass Incorporated
Leader Electric Manufacturing Corporation
Lighting Products Incorporated
The Miller Company
Mobeco, Inc.
Multi Electrical Manufacturing Company
National Electrical Manufacturers Association, Indust'l & Comm'l Lighting Equip. Section
Pennsylvania Wire Glass Company
Philadelphia Electrical & Mfg. Company
Pittsburgh Reflector Company
The Pyle-National Company
R.L.M. Standards Institute
Rambusch Decorating Company
L. J. Segil Company
Silvray Lighting Incorporated
A. L. Smith Iron Company
Smoot-Holman Company
Solar Light Manufacturing Company
Steber Manufacturing Company
Sterling Reflector & Manufacturing Company
Superior Electric Company
Superior Electric Co.
Swivelier Company Incorporated
Sylvania Electric Products Incorporated
Thompson Electric Company
Unistrut Products Company
The F. W. Wakefield Brass Company
Westinghouse Electric Corp., Lamp Div.
Westinghouse Electric Corp., Lighting Div.
Wheeler Reflector Company

These companies have indicated their confidence in the Society and in the future of ILLUMINATING ENGINEERING by being the first to select the pages of our official journal to carry their advertising message.

—ILLUMINATING ENGINEERING SOCIETY

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

JANUARY
1949

Vol. XLIV
No. 1

Another Step Forward — L. E. Tayler — 1

Architecture — Light — Color Create an Effective Environment for a Shoe Shop — 2

A Method of Analyzing Economics of Store Lighting — K. C. Welch — 5

Design and Illumination Characteristics of Louver and Louverall Systems—Part I — W. M. Potter and R. L. Oetting — 16

Third International Lighting Exposition to Assemble "Tools of the Trade" for Lighting Engineers — R. W. Staud — 28

Recent Developments in Lighting Equipments and Application—Report of I.E.S. Committee on Progress, 1947-48 — S. G. Hibben — 30

Lighting Data Sheets—Series XIV
Lighting of a Combination Living-Dining Room (22-10) — 41

Lighting a Subway Car (28-1) — 55

Is Lighting Application a Lighting Problem? — J. S. Hamel — 43

Light Sources and Colored Objects — R. M. Evans — 47

Miscellaneous Short Items

Louverall Lighting of a Boston Store Window, 54; Floodlighting of New England Life Insurance Tower, 46

TELECAST—Lighting News of Current Interest — 57

Index to Advertisers — 37A

G. Ross Henninger
Editor

Ruby Redford
Production Editor

Clayton E. Ellis
Advertising Manager

Publication Committee

E. C. Huerkamp, Chairman
Berlon C. Cooper
H. H. Magdsick
R. W. McKinley
Richard G. Slauer
Rudolf W. Staud
Francis I. Wilson

STATEMENTS and opinions in articles and papers in **ILLUMINATING ENGINEERING** are the expressions of contributors and do not necessarily represent the policies or opinion of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council. Correspondence is invited on all controversial matters.

Published Monthly by the

ILLUMINATING ENGINEERING SOCIETY

Founded 1906

PUBLICATION office 32d Street & Elm Avenue, Baltimore, Md.

EDITORIAL and advertising offices 51 Madison Ave., New York 10, N. Y.

ILLUMINATING ENGINEERING. The Journal of the Illuminating Engineering Society. Copyright 1949 by the Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. †Subscription $10 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. †Address changes must be received at IES headquarters by the first of the month to be effective with the issue of the next succeeding month.

Here it is... the NEW FLEUR·O·LIER INDEX SYSTEM

THE GREATEST CONTRIBUTION TO LIGHTING SINCE FLUORESCENT!

Fleur-O-Lier Manufacturers proudly present to the lighting industry—the Fleur-O-Lier Index System—a method of specifying, identifying, and classifying fluorescent luminaires—with regard to their illumination characteristics.

There's been a long-felt need for a system of classifying fixtures—some method common to all who make, sell, specify or buy fluorescent fixtures.

This is it. It's simple, practical and basic.

"Why hasn't someone thought of this long ago!" say lighting engineers who have seen the Fleur-O-Lier Index System.

As Simple as A B C

WHAT IS IT?

The Fleur-O-Lier Index System is a simple method of identifying or describing any fluorescent luminaire on the basis of its illuminating performance.

WHY IS IT NEEDED?

Fleur-O-Lier Manufacturers devised the index system to give the "facts of light" about each luminaire. Because this classification quickly indicates the basic illuminating performance of a fixture, it eliminates vague generalities, broad but unfounded claims and gives needed factual data.

WHAT DOES IT ACCOMPLISH? *Its purpose is two-fold:*

1. It provides an exact formula which the specification writer may use to

FLEUR·O·LIER *Manufacturers*

Fleur-O-Lier is not the name of an individual manufacturer, but of a group of fixtures made by leading manufacturers. Participation in the Fleur-O-Lier program is open to any manufacturer who complies with Fleur-O-Lier requirements.

• For SPECIFYING Lighting Fixture Performance

• For IDENTIFYING Fluorescent Lighting Fixtures

express the illuminating characteristics and performance he recommends.

2. It supplies a precise formula for fixture identification and classification that allows the buyer to *know* he's getting the illumination recommended.

WHO'LL USE IT?

Architects, lighting engineers, lighting consultants, lighting salesmen, contractors and utility lighting men . . . anyone who specifies or recommends lighting fixtures can use this simple, practical and fool-proof method to give an exact definition of the illuminating performance he selects for an installation.

Fixture manufacturers will use the system to indicate the performance characteristics of their fixtures.

Buyers and users will employ this method of indexing to make certain they are getting what the specifier recommends.

HOW DO I GET IT?

The Fleur-O-Lier Manufacturers have prepared a booklet which explains the Fleur-O-Lier Index System completely . . . what it is and how to apply it. It's complete with tables. Use the coupon below to send for your free copy of the new booklet.

AND HERE'S WHY YOU SHOULD INSIST ON THE FLEUR•O•LIER *Label*

The Fleur-O-Lier label means that the fixture was built to exacting specifications—then tested, checked and certified by Electrical Testing Laboratories, Inc. The Fleur-O-Lier label assures you of sound mechanical construction, safe and proper electrical design and materials, and tested, certified lighting performance.

To be sure of precise illumination characteristics, long trouble-free operation and complete user satisfaction—insist on the Fleur-O-Lier label.

Fleur-O-Lier Manufacturers
2116 Keith Building
Cleveland 15, Ohio

Gentlemen:

Please send me a free copy of the booklet describing the Fleur-O-Lier Fixture Index System and containing the Fleur-O-Lier Specifications and Testing Procedures.

NAME_____

COMPANY_____

STREET_____

CITY_____ STATE_____

1 INTEREST GOAL

NEMA MEMBERS Who Manufacture Industrial and Commercial Lighting Equipment

ALL-BRIGHT ELECTRIC PRODUCTS CO.
Chicago 18, Ill.

ART SPECIALTY COMPANY
Chicago 24, Ill.

BENJAMIN ELECTRIC MFG. COMPANY
Des Plaines, Ill.

BRIGHT LIGHT REFLECTOR CO., INC.
Bridgeport 5, Conn.

CENTURY LIGHTING, INC.
New York 19, N. Y.

CIRCLITE CORPORATION
Chicago 6, Ill.

COMPCO CORPORATION
Chicago 47, Ill.

CURTIS LIGHTING, INC.
Chicago 38, Ill.

DAY-BRITE LIGHTING, INC.
St. Louis, Mo.

EASTERN FIXTURE COMPANY
Boston 20, Mass.

ELECTRO MANUFACTURING CO.
Chicago 12, Ill.

ENDER MANUFACTURING CORP.
New York 13, N. Y.

FARIES MFG. CO.
Decatur, Ill.

FLUORES-O-LITE COMPANY
Hillside, N. J.

FOSTORIA PRESSED STEEL CORP.
Fostoria, Ohio

THE FRINK CORPORATION
Long Island City 1, N. Y.

GARDEN CITY PLATING & MFG. CO.
Chicago, Ill.

GENERAL DAY-LITE COMPANY
Philadelphia 42, Pa.

GENERAL LIGHTING COMPANY
New York 3, N. Y.

GENERAL LIGHTING PRODUCTS CO.
Newark 5, N. J.

GENERAL LUMINESCENT CORPORATION
Chicago 5, Ill.

GILL GLASS & FIXTURE COMPANY
Philadelphia 34, Pa.

GLOBE LIGHTING PRODUCTS CO.
New York 16, N. Y.

GOOD MANUFACTURING CO., INC.
Chicago 10, Ill.

HOLDENLINE COMPANY
Cleveland 13, Ohio

HOLOPHANE COMPANY, INC.
New York 17, N. Y.

THE JONES METAL PRODUCTS CO.
West Lafayette, Ohio

KENT METAL MFG. CO., INC.
Brooklyn, N. Y.

THE KIRLIN COMPANY
Detroit 7, Michigan

MORRIS KURTZON, INC.
Chicago 18, Ill.

LEADER ELECTRIC COMPANY
Chicago, Ill.

LIGHTING PRODUCTS, INC.
Highland Park, Ill.

MARKEL ELECTRIC PRODUCTS, INC.
Buffalo 3, N. Y.

THE MILLER COMPANY
Meriden, Conn.

MITCHELL MFG. COMPANY
Chicago 14, Ill.

MOBILITE, INC.
Jersey City, 6, N. J.

MOE-BRIDGES CORPORATION
Sheboygan, Wis.

MORLITE EQUIPMENT COMPANY
Girard, Pa.

OVERBAGH & AYRES MFG. CO.
Chicago 7, Ill.

THE PERFECLITE COMPANY
Cleveland 14, Ohio

PITTSBURGH REFLECTOR COMPANY
Pittsburgh 22, Pa.

PLANET PRODUCTS, INC.
Chicago 8, Ill.

QUADRANGLE MFG. COMPANY
Chicago 7, Ill.

REVERE ELECTRIC MFG. CO.
Chicago 40, Ill.

RICHTER METALCRAFT CORP.
Mt. Vernon, N. Y.

RUBY-PHILITE CORP.
Long Island City 1, N. Y.

S & M LAMP COMPANY
Los Angeles 54, Calif.

L. J. SEGIL COMPANY
Chicago 47, Ill.

SILVRAY LIGHTING, INC.
New York 20, N. Y.

SMITHCRAFT LIGHTING DIV.
A. L. SMITH IRON COMPANY
Chelsea 50, Mass.

SMOOT-HOLMAN COMPANY
Inglewood, Calif.

SOLAR LIGHT MFG. CO.
Chicago 7, Ill.

THE SPERO ELECTRIC CORP.
Cleveland 19, Ohio

SUNBEAM LIGHTING COMPANY
Los Angeles 21, Calif.

SUN-LITE MANUFACTURING COMPANY
Detroit 7, Mich.

SWIVELIER COMPANY, INC.
New York 3, N. Y.

SYLVANIA ELECTRIC PRODUCTS, INC.
Ipswich, Mass.

KURT VERSEN COMPANY
Englewood, N. J.

THE F. W. WAKEFIELD BRASS CO.
Vermilion, Ohio

WESTINGHOUSE ELECTRIC CORP.
Cleveland 1, Ohio

WHEELER REFLECTOR COMPANY
Boston 10, Mass.

R. & W. WILEY, INC.
Buffalo 7, N. Y.

THE WIREMOLD COMPANY
Hartford 10, Conn.

the Public Interest

ever higher Standards of Illumination

Our program is founded on the proposition

"He Profits Most Who Best Serves"

It is dedicated to the public interest and thus cannot but profit all who are identified with the Lighting Industry . . . be they electrical contractors . . . wholesalers . . . architects and engineers . . . electric light and power men . . . or the many other groups which directly or indirectly have a stake in the well-being and future of lighting.

The members of this Section of NEMA are interested in raising the standards of illumination:

first — by recommending lighting installations designed in accordance with Recommended Practices of the Illuminating Engineering Society . . .

second — by having the lighting equipment they manufacture so designed as to conform with sound principles of modern illuminating engineering . . .

third — by engaging in various activities as may promote higher standards of lighting such as:

- Full cooperation by all manufacturers to make the PLANNED LIGHTING PROGRAM effective on the local level
- Sponsors of THE INTERNATIONAL LIGHTING EXPOSITION AND LIGHTING CONFERENCE
- Sponsors of THE MERIT AWARD COMPETITION
- Participation in development and promotion of AMERICAN STANDARDS affecting lighting equipment and practice
- Promotion of acceptance for NATIONAL ELECTRICAL CODE
- Cooperation with ELECTRICAL LEAGUES
- Support and promotion of ADEQUATE COMMERCIAL AND INDUSTRIAL WIRING DESIGN STANDARDS

In general . . . the Industrial and Commercial Lighting Equipment Section is actively interested in promoting any activity or movement which, because it will provide a finer service to the public, will expand the market for industrial and commercial lighting equipment.

The Industrial and Commercial Lighting Equipment Section

National Electrical Manufacturers Association

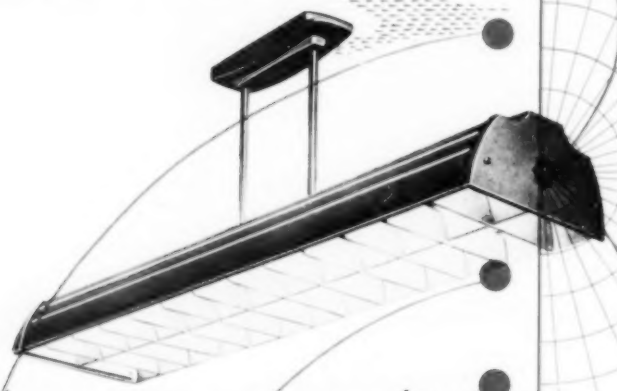
155 East 44th Street, New York 17, New York

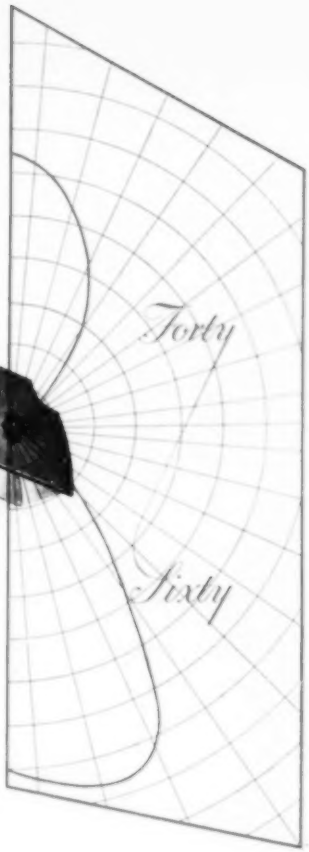
R3133

the "forty-sixty"

a low brightness luminaire

designed by CURTIS





to produce optimum seeing conditions

The growing trend toward Appropriate, Brightness, Control in modern lighting emphasizes more and more the characteristics of the "Forty-Sixty". A low-brightness unit, it directs 40% of its light upward and 60% down to the working plane. Shielded 35° crosswise and 25° lengthwise, this Alzak Aluminum unit is both easily installed and maintained.

Capitalize on the need for ABC lighting . . . get full details about this luminaire.

CURTIS LIGHTING, INC.
6135 WEST 65th STREET, CHICAGO 38, ILLINOIS
CHICAGO . . TORONTO . . NEW YORK

Another Step Forward—

THIS ISSUE of ILLUMINATING ENGINEERING represents an important milestone in the history of the Illuminating Engineering Society. With it, a new and broader publication service to the entire lighting field is inaugurated, representing the first step in the fruition of long-developed plans.

A NEED for revision and expansion of the Society journal has been reported by many Society presidents, after completing their visits to Sections and Chapters, where they discussed the matter personally with individual members in all parts of the country. It was widely believed that the technical content should be augmented by articles covering more comprehensively current illuminating engineering practice as well as all phases of the basic science and art of lighting. Some members expressed a desire for significant news items of general interest and for a more readable treatment of events and progress in our Sections and Chapters and of the activities of our technical committees. In short, the consensus was that the Society required a publication that would fulfill more completely and more effectively the needs of a rapidly growing membership, and one that would better present the Society's programs, opportunities, and objectives. Vigorous leadership and the tireless efforts of the committees charged with the responsibility of producing a revised journal have made possible this new Illuminating Engineering. They are to be highly commended, especially the Task Committee charged with the revision project, the Publications Committee, and the Editorial Department.

AN INTERESTING STORY lies behind the launching of this enlarged publication, a story that should be told. It has to do with the forward thinking of one of our members. Many men who can anticipate the future, find, on giving expression to their views, they must await favorable circumstances for fulfillment. In his Presidential Address in 1930, H. H. Magdsick pointed out the need and expressed the advantages of improving the format and broadening the scope and editorial content of the Society's publication. He foresaw then the benefits to the membership and to the lighting field generally of a journal of broadened scope. At about the same time an opportunity arose to launch a ten-year program of Society-sponsored prize competitions for architectural students through the Beaux Arts Institute. All agreed that this program should have priority over other new ventures. The depression and the war years intervened and, when new projects could be resumed, the publication of an I.E.S. Lighting Handbook was given the right-of-way. In 1946 President Hardacre responded to the interest expressed by the membership in a new journal by appointing Mr. Magdsick chairman of a task committee to undertake the responsible assignment of exploring the content and format of the needed publication, and the means for bringing it into being.

A REALITY NOW, we have in this publication a medium through which it is possible to effect as never before a constant interchange of current knowledge and experience in the solution of lighting problems arising throughout the field. For example, a member of the Southern California Section solves an intricate problem of inspection lighting in the Aircraft Industry. He will write the story of his experiences, and together with photographs send it in for publication under his name. A member of the Toronto Section has information and experience which would benefit all of us concerning Street and Highway lighting. Why not read about it in I.E.? A member of the Michigan Section has solved a problem of lighting "spotting tables" in the Cleaning and Dyeing Industry. It should also make interesting reading. Across the United States and Canada, North, East, South and West, our members have a wealth of information on the application of illuminating engineering. This new journal now provides the medium through which we can all learn what the other fellow is doing.

TO THE CHARTER ADVERTISERS in our publication we extend our appreciation for your confidence. Your monthly messages on products and services will add to the interest of ILLUMINATING ENGINEERING, and make it of greater value to our 7,437 readers, who so largely determine the trends in lighting practice.

L. E. Tayler

L. E. TAYLER
President

Architecture - Light - Color

Create an Effective Environment for a Shoe Shop

OCCUPYING a valuable corner in the "Magnificent Mile" development of Michigan Avenue on the near north side of Chicago is a new Chandler Shoe Store. The architects, Holabird and Rood and Burgee, have given the store a pleasing prominence both by day and by night. Exterior and interior have been integrated to provide an ensemble that is interesting and stimulating, effective as a merchandising unit. This distinction is the result of skillful coordination of form, appointments, finishes, lighting, color, decoration.

The lighting is of special interest on several counts: The means used to attract attention and to identify the establishment; the brightness pattern that guides attention within the store and creates for those outside an effective combination show window and open front treatment; the atmosphere and emotional character achieved.

Street View

A skillful combination of show windows, open front, and unusual facade in glass and stainless steel compellingly attracts the attention of both pedestrian and automobile traffic. The upper glass facade has a huge nylon curtain hung five feet behind the window. At night this large surface of hand-blocked blue pattern on a white nylon background becomes commanding in brightness as well as in size. The well-scaled horizontal bands support the silhouette sign on the front and the one in white tubing facing the side street.

Lighting is applied to the background from three locations (Fig. 4): Double rows of 96" and 72", T8, 4500° white slimline lamps operated at 300 milliamperes are placed in continuous troughs behind the horizontal stainless steel bands. A continuous louvered troffer is recessed in the soffit. It acts very much as a border light on a stage. Three rows of slimline lamps are used at 300 milliamperes. A strip with 150-watt PAR-38 spotlights on three-inch centers is located in the space at the foot of the curtain. These direct light upward and give an interesting gradation of color mixtures with the light from the 4500° white slimline lamps above. The range of brightness is of the order of 35 footlamberts near the bottom and 70 footlamberts, middle to top.

Show Windows

Show windows are enclosed with glass on the inside as well as the exterior for protection of the materials. In this respect they are similar to island windows, yet the displays serve the people inside as well as outside, and those on the street also are able to look through the length of the store. From this viewpoint the luminous treatment of the real rall provides a bright background which reduces veiling images from the glass.

To emphasize styling, finish, and color of merchandise on display, a combination of incandescent and fluorescent lighting is installed.

Fig. 1—The scale of the stainless steel bands, the brightness of the nylon curtain and the well-coordinated signs are dominant features marking the store.

Fig. 2—No matter in which direction the patron looks, the interior is interesting because the whole perimeter is effectively used for emphasis of displays.

For the *incandescent general lighting*, 200-watt lamps in mirrored-glass show-window reflectors are recessed in the ceiling on 24-inch centers around the perimeter of each window.

For the *fluorescent general lighting*, the center section is devoted to eight recessed rows of 64-inch and 42-inch T6 slimline lamps in polished parabolic reflectors. These are louvered in both directions.

Accent lighting for the feature displays, generally located in the center of each window, is provided with 150-watt PAR-38 spots placed along the center of the fluorescent units and fitted flush with the louvers. These spots are on 30-inch centers and mounted in gimbals to give flexibility in aiming. This arrangement gives a luminous intensity of 225 footcandles on general displays and 350 on featured displays.

Interior

The first feeling on entering the store is one of well-being, to which the deeply padded carpet and smart appointments, the quiet coloring, the intriguing decoration, and well-studied lighting all contribute. The atmosphere is one that appeals strongly to feminine clients because its elements are complimentary. The fluorescent 4500° white color is deliberately employed in combination with filament units—the 4500° white for clean, crisp appearance and its compatibility with daylight—the

Fig. 3—Upon stepping into the store, the patron's impression is one of well-being. The brightness pattern of the lighting contributes much to that effect.

superposed filament component for its suggestion of sunlight and contribution to patrons' complexions.

The general tone of walls is light gray, with the front wall above the display windows in subdued yellow. The floor covering also is gray. Wood finishes are natural so that these with the other main surfaces in the interior are neutral. Accents in color are introduced by the merchandise, by the chair fabrics, and by the column decoration. The unusual treatment of columns is a pattern of yellow, white, gold leaf, and gray contributes a distinctive character. This was an interesting experiment which has received very favorable comment.

General Lighting

From both architectural and lighting standpoints, a novel feature is the general lighting from narrow slots in the ceiling. These are 3½-inch openings at the secondary focus of recessed elliptical trough reflectors. These long cavity units serve to give to most of the shoes a pattern of highlights that emphasizes their styling. Each such is equipped with a 4500° white 64-inch T6 slimline lamp operated at 300 milliamperes. The lamps are shielded to 40 degrees in both directions, and the brightness of the reflector at normal angles is low.

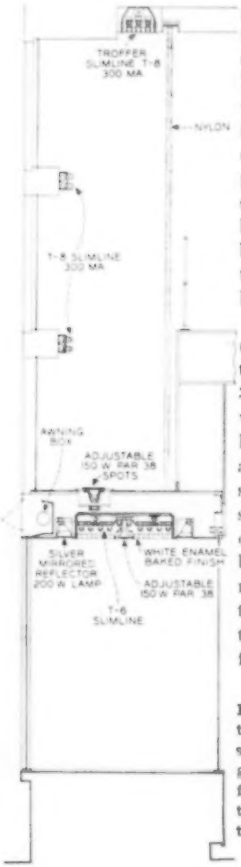


Fig. 4 — Vertical section through the store front showing arrangement of general and spot lighting for the show window and the method of achieving the dramatic effects of the facade.

The recessed circular units in the ceiling pattern are 150-watt PAR-38 floodlights. They provide the bright highlights on shoe surfaces and trim, while the line sources help to emphasize styling. The fluorescent lamps in coves on both sides of the store reduce contrast and contribute to the illumination as well as to the feeling of spaciousness.

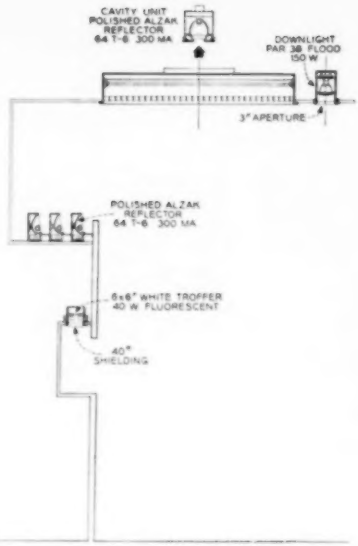


Fig. 5—Vertical section interior wall (left, Fig. 2) and ceiling, showing methods of achieving localized lighting on merchandise on shelf-alcove, cove lighting for the ceiling, and the line-spot design of ceiling units. In the cove, the axis of each parabolic cove reflector passes in the clear above the top edge of the unit in front of it, thus avoiding any blocking effect.

The average illumination from all components of the system is 50 footcandles.

Supplementary and Display Lighting. Displays in niches and wall cases are emphasized by lighting incorporated for that purpose. Recessed louvered uints for 4500° white fluorescent lamps are installed in the soffits. In the floor cases 64-inch T6 slimline lamps are used. The combination gives up to 200 footcandles on displays.

To enliven the rear of the store and to induce greater circulation, a bright pattern incorporating vertical lines is employed. This effect is created by vertical elements in silhouette carrying 96-inch slimline lamps which light the rear-wall background. The displays set in front of this luminous background are given accent lighting by spotlights in the ceiling. This treatment not only serves to draw customers to the rear of the store and to make of the whole room a more completely planned ensemble, but also becomes a key element in bringing the whole store into the night-time view.

Architect for the installation is W. Emil Forman, of the Edison Brothers Stores, Inc., operators of Chandlers.

Herman M. Lazerson was consultant on lighting.

A Method of Analyzing Ecnomics of Store Lighting

By KENNETH C. WELCH

The costs of lighting a sales area are considered in this paper from the standpoint of the productivity of the particular area. It would be rather difficult for instance, to justify today 60 cents a square foot for lighting costs in a furniture store, or men's clothing department, producing only $40 a square foot in net sales per year. A method of analyzing these economics of store lighting, applicable to department and all types of specialty stores, is outlined, based on twenty-five years' productivity records.

IN GENERAL, the analysis of the economics of a store's lighting is the same for small specialty shops as for large department stores carrying similar merchandise. However, there are many variables. Cost of lighting information is always a complicated subject. Any suggestions for such evaluation must serve only as a general framework within which total lighting costs as they are related to sales, and other operating expenses, may be more closely determined.

Various sections and groups of merchandise in department stores have been used in our comparisons because they include most of the merchandise departments found in many other stores in the general merchandise, apparel, home furnishings and kindred fields to which this discussion has been limited. In the summary chart of the I.E.S. Store Lighting Committee's "Lighting Practices for Stores and Other Merchandising Areas," published in June, 1948, the department store was used in a similar manner, but with departments from so-called convenience goods stores added; *i.e.*, food stores, and so forth. Further, we have a wealth of departmental operating statistics issued annually by the Controllers' Congress of the National Retail Dry Goods Association and by the Harvard University Graduate School of Business Administration.

Based on a paper presented before the Twin City Section of I.E.S., May 28, 1948.

KENNETH C. WELCH is Vice-President, Grand Rapids Store Equipment Co., Grand Rapids, Michigan. He is a member of the A.I.A.

Cost data by Mr. Leonard C. Blanding, I.E.S. of Grand Rapids Store Equipment Co.

The standards established, upon which this comparative framework was built, are:

1. *Standards of productivity* or sales per square foot of net selling area by kinds of merchandise. These have been grouped into three classifications; high, medium and low.

2. *Standards of quantity and quality of illumination* for these three kinds of areas.

3. *Standards of quality and consequent cost* (on an annual basis) of the lighting installation and its operation to achieve our standards of illumination. We have presented two: a minimum-cost and an optimum-cost system.

Productivity

Our standards of space productivity have been established from two of the five volume classifications as reported by department stores to the National Retail Dry Goods Association. They are (1) a smaller department store producing between two and five million dollars in sales annually, and (2) the larger store producing over ten million

This lighting of merchandise in and on a showcase is obtained entirely from ceiling sources, 15 footcandles from 4500 K fluorescent and 70 from PAR projector-spot luminaires with spread roundels; aisle lighting is only 20 to 25 footcandles. Note quality of light on the salesgirl's face, not an unimportant factor.

dollars (with average sales as reported of over twenty-six million).[1] We have used these two for comparison because (a) they represent certain desirable characteristics for our purposes, (b) they encompass a rather broad field, and (c) because one important variable is the relative increase in area productivity with an increase in total store sales. This latter ratio also tells us much about the degree of impulse sales of a given department.

Productivity of the departments and groups of departments have been averaged in these two stores in the interest of simplification, but we give the ratio of the varying average productivity in the two in terms of the percentage that the greater is over the lesser. This gives an idea of the average range in productivity of the older, unimproved store and a modern, efficient plant.

Appendix A lists these departments or, where practical, groups of related departments, indicating a general average of area productivity (given in net dollar sales per square foot per year) and other factual data. It will be noted that in this appendix the departments and/or groups have been listed in three general divisions of productivity: high productivity, exceeding, as a general rule, an average of or with a potential of $200 per square foot per year and up; medium productivity, about $100 to $199 per square foot; and low productivity, under a general average of $100 per square foot. These three groups should also be listed in terms of customary average location within a department store in relation to natural traffic. High-productivity sections are always in a preferred location on the main floor; the medium-productivity sections are in the less preferred main floor areas or preferred locations on the upper floors; and the low-productivity sections are on the uppermost floors in the less accessible areas.

Because of certain features mentioned later, a few sections in the medium group have a potential well in excess of the average $200 per square foot; for example, domestics (white goods), women's coats and furs, and knit underwear. However, because these sections logically fall within groups of medium productivity, they have been so listed.

The more detailed productivity figures have been listed, first, to give an idea of the considerable variation in productivity by departments and by different stores. Second, lighting design and quantitative results and costs can—as we have done—be easily computed on an area basis. Also, modern department stores compute by departments their operating expenses (and profits) as a percentage of their net sales, and also furnish comparative sales on an area basis. As a result, such a table can be of value to the illuminating engineer when the matter of detailed economics becomes important in developing a plan for a particular kind of store lighting.

However, the productivity figures of individual departments as reported to and listed by the National Retail Dry Goods Association are often rather erratic and seem at times irrational. This is due to the fact that they are governed by over a dozen varying factors. These factors include such items as (a) varying geographical, economic and climatic conditions, (b) methods of computation by the store, (c) efficiency of store layout, (d) value of the dollar in terms of various merchandise, (e)

[1]Note: To give an indication of the size of these two stores, the smaller with typical productivity, might occupy a plot 100' x 200' with four floors plus basement, and with goal productivity, basement and two and a half floors. A modern suburban branch store would use a building plot area of 150' x 200' and sell on only two levels plus a service mezzanine. The larger store, with typical productivity, might occupy a plot 250' x 250', with eight floors and basement, and with goal productivity, a structure of less than six floors plus a basement. Home furnishings sales would require warehouse space in addition.

Below, left. Bags and jewelry displayed under indirect fluorescent lighting. Brightness of the white background is 24 ft-L; foreground 30 ft-L; highlight black bag, 1.3 ft-L, shadow black bag, 0.34 ft-L; illumination level 37 ft-c. Below, right. Same merchandise under two direct incandescent sources, one a spot. White background, 66 ft-L; foreground 40 ft-L; illumination level 43 ft-c. Gives sparkle to jewelry, creates the necessary highlights and shadows to bring out the sheen in the satin and the texture of the leather.

distance of stores from various market centers in relation to quantity of stock, (f) size or bulk of the merchandise and area consumed for display, (g) problems of stocking styles and sizes, and (h), under certain circumstances, the average gross sales.

We have kept productivity records for twenty-five years. Having made actual surveys of a considerable number of stores, and having modernized them or designed new stores with these factual data as a basis, we have been able to analyze these variables to arrive at potential productivity figures. When approaching goal figures, of course we must assume expert store management and physical conditions which make possible a store plan with a high degree of efficiency.

These surveys have resulted in a series of curves which smooth out many of the erratic factors found in the reported productivity results, and which also indicate a better standard of performance than can be achieved through contemporary store layout analyzation and practices. This results in not only a much higher than average productivity, but in the light — or perhaps darkness — of today's construction costs, can result in an important and necessary profit to the merchant. In this connection, it is well to remember that new stores constructed or even modernized today are in competition with many stores constructed when building costs per square foot were about 50 per cent lower. High productivity, therefore, in new stores, becomes a necessity from a competitive standpoint. From these curves, within any given store, we have been able, for purposes of simplification, to establish these three basic productivity groups.

It should be emphasized, however, that these productivity figures are only averages. With really efficient planning, freed from many past inhibitions and rule-of-thumb methods, these averages are consistently exceeded by 50 per cent. In older stores, they can be considerably less.

The right kind of lighting has a great deal to do with achieving maximum productivity. The total annual cost of the right kind of lighting in relation to the sales and other operating costs, therefore, can be of some importance in the initial planning stages, because in lighting it is not always a matter of original cost so much as the matter of upkeep.

Standards of Illumination

We have limited these standards, first, to three basic levels, compatible with good brightness ratio design and sensible costs and based on the productivity of a given type of merchandise. These standards, under certain circumstances, should be raised. They should seldom, if ever, be lowered.

We have maintained what we consider to be a good and satisfactory standard of quality or sufficient brightness on the merchandise and low enough brightness ratios in the total environment, so that the lighting system and even the basic architectural elements are subjugated in most cases to the brightness of the merchandise itself. This does not mean that we produce a gloomy environment as contrasted to bright merchandise, but it does mean that the merchandise with the highest diffuse reflectance is as bright as any normally visible part of the lighting system.

For a good directional distribution pattern, we think it desirable to create general overhead brightness equal to 25 to 50 per cent of the brightness of the lighter tones or high reflectance merchandise or the immediate surround. This overhead brightness pattern can, in certain cases, produce the major part of what we can call the diffuse environmental lighting. In minimum-cost systems, we can afford but little totally indirect lighting for our

Below, left. Combination of indirect fluorescent and direct incandescent lighting. Background 90 ft-L; foreground 69 ft-L; illumination level 80 ft-c. Sparkle quality of display obtained with second photo holds true here also. Below, right, Direct fluorescent. Background 15 ft-L; foreground 28 ft-L; highlight on black bag. 1.9; shadow 0.26 ft-L. Though satin bag has sheen, indirect light makes it completely flat. This applies also to the alligator bag and the brilliants or faceted stones in the leaf pin.

diffuse illumination. We must resort to direct or direct-indirect fluorescent, but always properly shielded to keep within our brightness ratio standards.

Being first an architect-designer, I have always thought of directional distribution in lighting in terms of what is reflected from the all-important merchandise to the eye, rather than in terms that describe a particular kind of lighting fixtures. It is easy to demonstrate that a great deal of fashion and novelty merchandise, with its varying textures, surface characteristics, and forms, is best lighted with a combination of (1) large area, low brightness, cool source (which I call diffuse illumination) and (2) a stronger, warm, single directional source. This diffuse illumination on the merchandise can come from either a totally *indirect* system or a *direct* fluorescent system for most soft goods. The only case where the difference is greatly noticeable to the eye is with merchandise having a surface which is highly specular. The lighting must then be planned so that the lighting sources themselves (best concealed from normal viewpoints) can be reflected to the eye from the merchandise.

This matter of maintaining a rather tranquil brightness adaptation on the part of the customer, of not blasting them, so to speak, with brightnesses twenty to two hundred times that which we can economically produce on the merchandise, is just common sense. It makes even more sense where impulse sales in many departments are so important. This means, of course, that the lighting system must be rather effectively concealed. It also means that the so-called open store front must always be examined from two viewpoints, the exterior and the interior. Open front stores can create a devastating glare on a bright day from the interior viewpoint.

In many discussions on the 3 A's, and Attraction in particular, there has been some confusion. It is not a matter of attracting attention to a lighting system by relative brightness, but to the merchandise. An attractive store has to do with Atmosphere.

However, the great majority of high- and medium-productivity sections require, as we have mentioned, in addition to this diffuse illumination, a strong directional light which only the efficient control of an incandescent point source makes possible. The combination of this incandescent source with diffuse fluorescent produces an ideal spectral distribution as well as directional quality for this kind of merchandise. These qualitative standards are better than average, but that is one of the niceties possible with the proper cooperation between a modern designer and an understanding engineer. We are convinced that when these qualities are achieved, they more than pay their own way in increasing sales and profits.

The standards, briefly, using the nomenclature of the Store Lighting Committe's summary chart, are:

1. High-Productivity Sections

(a) Selling or appraisal lighting—2900°K direct, 50 ft-c over 45 per cent to total sales area.[2]

(b) General environmental lighting—4500°K to 6000°K, 15 ft-c average total sales area.

(c) Display lighting—equal to 100 ma fluorescent lamps (about 6.25 watts per foot) in certain show cases and center-of-the-floor cases, averaging one lineal foot of lamp per 20 square feet of net sales area, or about 0.31 watts per square foot.

It might be noted that this does not represent current practice. It is a more or less idealistic approach to store lighting based on the writer's oft-expressed theory of low brightness ratios to permit a brightness adaptation on the part of the customer so that the extremely high levels of light which cause fading in show cases may be eliminated. This is especially true when, for example, an average of 65 footcandles is furnished on top of the case. At least 70 per cent of this level is added to the illumination in the top part of the show case.

Many stores have been satisfactorily lighted without any show case lighting by using a little higher level on top of the cases and handling the decorations carefully to give the light-colored merchandise brightnesses exceeding those on any of the architectural surfaces.

2. Medium-Productivity Sections

(a) Selling or appraisal lighting—2900°K direct, averaging 25 ft-c over 50 per cent of the sales area.

(b) General environmental lighting, 4500°K to 6000°K, 10 ft-c average for total selling area.

(c) Display lighting—averaging 40 square feet of floor per foot of lamp at 6.25 watts per lineal foot, or about 0.156 watts per square foot.

3. Low Productivity Sections

(a) Selling or appraisal lighting—2900°K to 3500°K, averaging 12 to 14 ft-c over 20 to 25 per cent of the sales area.

(b) General environmental lighting—3500°K to 4500°K, averaging 12 to 14 ft-c over the total sales area.

(c) Displayed stock lighting—separate from the sum of (a) and (b) only occasionally and would not average over 0.1

[2]Sales area is defined by the National Retail Dry Goods Association as all area used for selling, including selling and display fixtures, forward stock-carrying equipment, aisle spaces (properly allocated to departments), fitting rooms, service desks (on the sales floor), etc. Selling zone, as we use it, refers to the actual zone in which merchandise is shown to the customer for examination. Obviously, on most main floors using show cases and counters, it does not include the circulation areas or some stock areas.

[2]The original standard established for an average level of 50 footcandles in 45 per cent of the area was based on using projector lamps without lens control. This might be improved in the future so that one can, in these high-productivity sections, or in the counter selling areas of the medium-productivity sections, put the light and the brightness where it is needed and where it can create the highest brightness to attract attention. The need for a 75-watt projector lamp is becoming more evident in all high-productivity sections and some low-productivity sections with the lower headroom not for economy in lamp replacement costs, but for reduction in energy costs and in radiant heat. The lower headroom in new construction, because of its economy, shorter distance between floors, and possibility of brightness control, is becoming increasingly popular

watt per square foot. In most cases the actual display lighting for the wall cases can also furnish a good share of the environmental lighting.

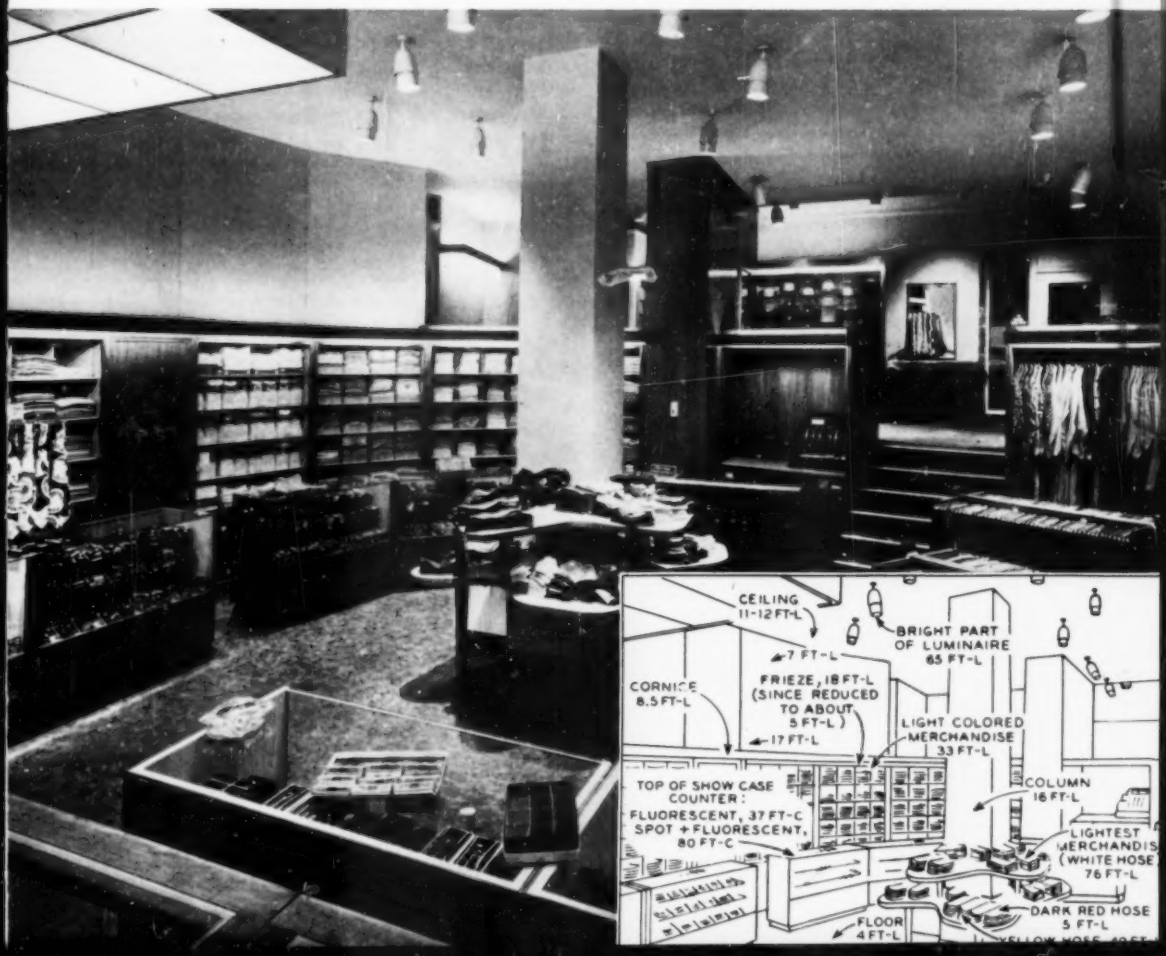
One reason for recommending the warmer environmental lighting for low-productivity sections is that in this case environmental and selling light may be combined, and it can all be fluorescent. As a matter of fact, it is very difficult today to justify economically new furniture stores because of their low productivity. Obviously, when one cannot combine a high level, warm incandescent with cool fluorescent, it is better to go to the warmer fluorescent.

Selling or Appraisal Lighting for High-Productivity Merchandise

This consists of 2900°K direct incandescent with the distribution carefully controlled by reflectors or reflectors and lenses to produce an average of 50 ft-c over 45 per cent of the total selling area.[3] This includes all selling and appraisal zones; *i.e.*, show cases, counters, selling tables, areas adjacent to wall or floor cases accessible to customers. It is not planned to cover general circulation areas or display cases otherwise lighted or concealed stock rooms. When control equipment can be improved and possibly some new lamps produced, this higher level could be reduced to possibly 30 per cent of the sales area, with some attendant economies, especially in the cost of energy.

When we specify an average of 50 ft-c for selling lighting, this would intentionally vary from 25 ft-c to 100 ft-c. For example, jewelry and candy can use, in part, 100 ft-c, whereas sections like hand-

General view of a store sales area in which general illumination is provided by fluorescent cove units, merchandise being highlighted from ceiling spots. Showcases and counter tops receive 80 footcandles, 37 from fluorescents, and remainder from spots. It is seen that some of the lighter colored merchandise at 76 footlamberts is brighter than anything else in the field of vision, including the brightest part of the luminaire. Merchandise in wall cases is illuminated mostly from the two-way cornice lighting. The band above the wall cases, which shows a brightness of 80 footlamberts in this photo, was later refinished to a darker color, reducing the brightness to 5 footlamberts to the benefit of merchandise display.



kerchiefs, women's neckwear — merchandise generally of higher reflectances easier to appraise and requiring less illumination for a given standard of brightness, can have lower levels for selling light of from 15 ft-c to 25 ft-c. (Of course, to the selling light level must be added that of the general environmental illumination which, in this latter case, could have an average of 10 ft-c, to produce a total selling illumination of 25 to 35 ft-c. This presupposes a certain amount of flexibility in the direct selling light in these high productivity sections, which is possible and obviously desirable to achieve.)

General Environmental Lighting for High-Productivity Sections

This is most economically produced by the lower brightness, more efficient fluorescent source. As we have intimated, it is already partly diffused for us to start with. This matter of producing planned brightness on the architectural surfaces—the ceiling, walls, and floors—to create a pleasing environment and hence a desirable mood, gives the designer almost a new medium to work with when he thoroughly understands its proper application.

When we have 50 to 100 ft-c of 2900°K direct illumination, we can use 6000°K environmental illumination and still produce a desirable spectral distribution on the merchandise. The cool shadows emulate better the effect of the most universally admired natural light—when the sun is shining.

Display Lighting for High-Productivity Sections

We have assumed a modern, free plan with a proper balance of circulation, selling and stock facilities. In such a plan the lineal footage of selling perimeter (show cases, counters, tables, etc.) is less per square foot of total area than on the older, conventional grid or rectangular plan. It is used, however, much more efficiently and, hence, more uniformly. In other words, the sales per lineal foot of selling is very materially increased; in fact, it is commonly doubled over the older type plan. It averages between twelve and sixteen square feet of sales area per lineal foot of selling perimeter. With our high levels of selling light—for example, 100 ft-c over a jewelry show case—and with low brightness ratios, we do not always require separate show case lighting.

Also, we do not require special displayed stock lighting in open-counter selling or over tables. It is often desirable, however, to illuminate with fluorescent lamps, at a low brightness per lineal foot, the show cases and all floor displayed-stock fixtures (generally below the eye line and carrying stock for so-called center-of-the-floor islands) which carry medium to darker toned merchandise.

The low brightness can be from fluorescent lamps operated at lower milliamperage, and this, together with the higher levels of selling lighting, provides enough brightness inside the case to reduce the veiling glare from the overhead brightnesses to a minimum. This method also reduces to a minimum the destructive fading which can become a serious problem when general line fluorescent lamps are used inside the case, which generally places this bright source too close to the merchandise.

In examining several modern plans, we find in high-productivity areas that only from 50 to 70 per cent of the selling perimeter facilities need be illuminated. In our standards, to arrive at annual costs, we have included only the additional energy cost for about 50 per cent of this perimeter, as the lighting equipment is generally a part of the store fixture and would be figured in those costs.

Selling Light for Medium-Productivity Merchandise

This can be similar in many respects to the similar classifications of selling and environmental lighting for the high-productivity sections, except at a lower over-all-level. However, in the many apparel and accessory sections which fall within this productivity range, we can concentrate our appraisal zones so that we can produce up to 100 ft-c in limited appraisal areas in front of selling

Need for wall case lighting and toning down of too bright floor is apparent in this general view of white shirt department, which now shows too much light at 90 ft-c.

mirrors, on the floor or in fitting rooms. We must use care, however, to keep this level of illumination, which must be largely strongly uni-directional off of "milady's" face.

In sections such as woolen fabrics, "appraisal zones" with levels up to 100 ft-c with a balanced spectral distribution of at least 15 per cent 6000°K and the remainder 2900°K incandescent are desirable. It is this kind of appraisal zone illumination, properly placed, that eliminates the necessity of windows in the modern store.

Environmental Lighting for Medium-Productivity Merchandise

This, again, is very similar to our high-productivity sections, except that we have considered it to be about 33 per cent lower in level. It is important that the lower ceilings, often encountered in these medium-productivity sections, be considered in the design of the distribution of light. We have used as our standard 15-foot ceilings for high-productivity and 11-foot ceilings for medium and low productivity. These are lower than a great many present stores, but we feel, with modern lighting and ventilating practices, it is possible to reduce the cost of the structure and the cost of moving people from level to level with these lowered ceilings.

Displayed Stock Lighting for Medium-Productivity Sections

Here, again, a great many of these sections are often segregated into shops, with higher cases forming the boundary lines, so that dual lighting illuminating the cases and overhead areas can be satisfactorily used. However, in such departments coming within this productivity group, such as children's departments, stationery, women's underwear and women's sportswear, we could have reflectors in some of the show cases.

Lighting for Low-Productivity Sections

Here it is very often possible to combine the selling and the general environmental lighting. This is especially true when we consider the new fluorescent sources available in the vicinity of 3000°K. However, we have made provision in our costs to have some so-called accent lighting for key display areas and other features in these departments.

We mention this because there is still a feeling on the part of the consumer-homemaker that for artificial lighting, they prefer the warmer incandescent lighting that they are used to in their homes. I think this is particularly true of the traditional home with limited window areas which, to prevent annoying glare, must be curtained. With more modern construction, using glass walls and with a rather higher maintained total brightness environment, we are going to become much more used to the varying spectral distribution of daylight. However, that time has not as yet arrived.

We must also remember that a great many home furnishings sections that fall within this low-productivity group display their own lighting fixtures. This is, of course, entirely true in the lamp department and it is also possible to distribute a number of lamps around the furniture floor. It should be noted that a number of home furnishings items, such as major appliances and furniture, have spectacular and semi-spectacular surfaces wherein properly designed fluorescent lighting can be of great value in bringing out the proper form of this type of merchandise.

Standards of Quality and Cost

We have created for comparative purposes what we have termed a minimum-cost and an optimum-cost lighting system. Both of these systems, however, are presumed to maintain our standards of quantity and, in the main, our standards of quality of illumination on the merchandise, as well as our general brightness ratio concepts.

In a similar manner to our consideration of the large and small department store, we can think of them as being in small and large cities. For example, in the 1945 figures, Harvard considers the $2,000,000-to-$4,000,000 store to be in a city of 70,000 persons, whereas the $20,000,000-to-$35,000,000 classification would be in a city of about 660,000 persons. The size of these cities alone can affect to some extent the cost of the lighting system as it pertains to the labor costs in installation and maintenance.

Also, the total environment from purely an aesthetic standpoint is perhaps not quite as important in the small city on Main Street as it is on Fifth Avenue in New York City or even on Nicollet Avenue in Minneapolis. Accordingly, the method of application of our lighting standards has a great deal to do with these two cost classifications. In other words, we might have to use more costly equipment—luminaire cost as well as installation cost and maintenance—and we might have to compromise efficiency to a greater extent to produce an architectural glamour, so to speak, that might be a necessary part of the high-fashion store in the larger city.

In general, in our minimum-cost system we have used the most economical equipment that would produce our standards. For example, we have assumed that most wall fixtures would combine display lighting and upward indirect illumination,

the latter to produce part of our environmental brightness and resulting diffuse illumination. As a matter of fact, we have some kind of patent, number 1,977,029, at least partially covering this kind of system. It has been infringed perhaps as much as any patent I know of.

For the center-of-the-floor diffuse illumination, we have used a minimum-cost, two-lamp louvered troffer, with the visible sides and louvers reduced in reflectance to maintain our brightness concepts.

In our optimum-cost system for our high- and medium-productivity sections, we have assumed some cove lighting, or some louverall ceiling design patterns, an occasional special hanging, totally indirect unit, and/or some totally indirect fluorescent units on the top of center-of-the-floor cases. This type of equipment would obviously be more costly and less efficient in producing our stated standards. The average engineer and perhaps some architects will not consider these more individual and more costly schemes to be more beautiful than the more functional, uniformly patterned troffers, but you can be sure that many architects and their Fifth-Avenue-minded clients will think them quite essential.

We have tried to select our minimum-cost equipment to be just that, to produce our standards. We doubt if they can be attained at a much lower figure, and in some localities, due to a number of factors beyond the control of the builder, these minimums will be exceeded for the same equipment. On the other hand, our optimum costs can well be exceeded with many specially designed systems that we can imagine, especially when the sky rather than a client's pocketbook is the limit. However, we do feel that a very fine installation can be provided within the costs we have estimated.

There is less differential in the cost of the incandescent direct accent selling lighting in the high- and medium-productivity groups. The difference in cost is largely in the method of concealment and the provision for flexibility we have used for the high-productivity sections, mostly recessed and camouflaged projector lamps, often adjustable. In the medium-productivity sections, we have figured efficient reflectors and standard filament lamps.

In the low-productivity sections, we have used largely fluorescent troffers with combined up and down lighting on the wall cases and so forth. We are including herein Appendix B which lists the

A combination of down incandescent lighting and direct fluorescent is shown in this men's wear display section.

Attractive highlights on this semi-specular merchandise are produced by direct overhead incandescent units using 100-watt IF lamps. The effect is heightened by low floor brightness.

component parts of the total annual costs. Note that we have used only two energy rates, one and two cents. They serve as an average comparison. This rate in smaller stores and shops is, of course, often exceeded.

We have tried to introduce all the costs that might conceivably be charged to lighting; interest on the investment and depreciation on wiring and equipment—we have even included interest on the investment in lamp stock. The lighting equipment and wiring have been amortized over a ten-year period, taking interest for that period at six per cent, which makes a total amortization and interest on the investment of 13 per cent. We have assumed lamp life at 80 per cent of rated life because in large stores, a systematic time system of renewal not only maintains better light, but can reduce labor costs for renewal and cleaning. This latter cost, with high levels of fluorescent general line lighting, can be so considerable that many economically-minded and budget-watching merchants are today scrutinizing this expense most carefully. Maybe cold cathode fluorescent offers the answer under many conditions.

There seems to be little published up-to-date data on the costs of replacement labor and cleaning. After consulting a number of stores, we have tried to arrive at a reasonable average cost. The ratios of the various expense divisions of lighting with the varying energy costs and the varying types of lighting, as shown in Appendix B, show some interesting results.

In addition to the cost per square foot, the percentages of the total cost for the various segments are shown. For example, in the high-productivity departments' optimum-cost system, the complete

Table I

	Sales Per Square Foot	Lighting Cost Per Square Foot	Lighting Costs % to Net Sales
Minimum-Cost System — Small Store — $\frac{1}{4}$ per Kilowatt Hour*			
High	$169	$.5575	.329%
Medium	$105	$.2770	.264%
Low	$ 57	$.2264	.398%
Total Main Store	$106	$.3069	.289%
Minimum-Cost System — Small Store — $.01 per Kilowatt Hour*			
High	$169	$.4296	.253%
Medium	$105	$.2066	.197%
Low	$ 57	$.1768	.311%
Total Main Store	$106	$.2183	.206%
Optimum-Cost System — Large Store — $.02 per Kilowatt Hour*			
High	$282	$.8334	.295%
Medium	$148	$.3811	.258%
Low	$ 87	$.3316	.380%
Total Main Store	$157	$.4019	.256%
Goal Total Main Sto e	$189	$.4019	.214%
Optimum-Cost System — Large Store — $.01 per Kilowatt Hour*			
High	$282	$.6774	.240%
Medium	$148	$.3094	.209%
Low	$ 87	$.2801	.322%
Total Main Store	$157	$.3309	.210%
Goal Total Main Store	$189	$.3309	.175%

*Note: The one and two-cent energy costs are simply given to indicate a range. It is seldom that a large store obtains lower than a one-cent rate and, of course, a smaller store can considerably exceed the two-cent rate. However, in the interest of simplification, it has been thought better to start at one cent and show the two-cent rate, to show the differential. It is not difficult to approximate other energy rates when these two are given. Obviously, a store producing two to five million, in the great majority of geographical locations, would be able to approach closely two cents per kilowatt hour. On the other hand, the majority of stores doing 25 million today commonly have an energy rate of one cent.

equipment and wiring costs are higher than the energy, both at one cent and two cents per kilowatt hour; namely, 44.6 per cent and 55 per cent for equipment costs as compared to 37.5 per cent and 23.0 per cent for energy. The only two instances where the energy cost exceeds the equipment cost is in the minimum-cost system for medium- and low-productivity when two cents is the energy rate.

Another interesting factor has emerged from these data: The cost of lighting the low-productivity sections in all categories is higher in percentage of net sales than for the other productivity groups. The high-productivity group is next highest and the medium-productivity is the lowest. The latter represents about 50 per cent of the area and, as shown in Appendix A, 55.75 per cent of the main store sales. This is interesting because these low-productivity home furnishings sections are causing some concern today to merchants. It is difficult to try to sell merchandise of this kind at a profit in buildings that are constructed at today's building costs. Accordingly, some large stores are talking about their suburban furniture sales expansion as roadside stands, in older structures which have been remodeled.

Table I shows relative lighting costs per square foot and lighting costs as a percentage of net sales

for various productivity groups and for total main store; of average total productivity and goal productivity for the optimum-cost system for the large department store.

To determine how these lighting costs, based on these better-than-average standards, compare in percentage of sales with average stores, we can consult the Harvard figures.

For stores with a volume of $20,000,000 to $45,000,000 for 1946, which is a larger store than we have used for our large store, they show, as reported to them, 0.35 per cent of the net sales for heat, light and power. However, the next smaller store, with a volume between $10,000,000 and $20,000,000 shows 0.4 per cent of the net sales for such utility services.

We have obtained a breakdown for a local department store which indicates their lighting costs are 50 per cent of this total item. If we can accept this premise—and of course it will vary with climatic and other conditions—then the average cost of the lighting as reported to Harvard for this volume classification would be somewhere between 0.21 per cent and 0.235 per cent of the net sales for the lighting alone.

Our optimum cost figured for our large store at $.02 per kilowatt hour would figure 0.256 per cent and at $.01, would figure 0.21 per cent. A great many of the large stores have an energy rate not exceeding $.01. So, IES standards, even for average productivity, fit into this average expense structure. However, when we can approach goal productivity and can also maintain these same standards of lighting at the same time reducing the lighting costs so that they are a compromise between our optimum and minimum standards, it is simple arithmetic to show that the modern department store cannot afford *not* to have a high standard of planned lighting. For example, with goal productivity, at $.02 per kilowatt hour, optimum lighting cost would figure 0.214 per cent of net sales, and at $.01, 0.175 per cent.

With a less costly lighting system and with a one-cent energy rate, it is not inconceivable to reduce lighting costs in relation to sales to an extent that can materially add to a store's profit in normal times.

The Harvard figures show that in the smaller store, heat, light and power will run from 0.45 to 0.5 per cent of the net sales. While we do not have any actual comparative figures, it is possible that the lighting ratios could be even higher than in the larger store. Even so, the smaller store would appear to have some difficulty keeping its lighting costs at an average and be able to maintain these standards and pay $.02 for their energy. It is certain that they must have today a system designed on a minimum cost basis.

Acknowledgement

The writer would like to acknowledge the assistance of Mr. Ray Ashley, Research Engineer of the Electrical Contractors Association of the City of Chicago, on the costs per outlet, and also of Mr. Peter Steketee of Kirkhof Electric Company, Grand Rapids, Michigan.

Appendix B

STORE LIGHTING COSTS PER SQUARE FOOT OF SELLING AREA PER YEAR

Productivity Classification Sales Per Sq. Ft. Per Year	HIGH $200 & Over		MEDIUM $100 to $199		LOW Under $100	
Lighting Levels for Selling—Appraisal Based on Watts per Square Foot	50 ft-c. 45% of Area 3 watts per Sq. Ft.		25 ft-c. 45% of Area 1.5 watts per Sq. Ft.		13 ft-c. Sectional .5 watts per Sq. Ft.	
Environmental	15 ft-c.		10 ft-c.		13 ft-c.	
Displayed Stock	.31 watts per Sq. Ft.*		.156 watts per Sq. Ft.*		.1 watts per Sq. Ft.*	
Classification of Lighting System Costs	**Optimum**	**Minimum**	**Optimum**	**Minimum**	**Optimum**	**Minimum**
Energy Rates Per kwhr.	.02 .01	.02 .01	.02 .01	.02 .01	.02 .01	.02 .01
Luminaire Costs Installed, $	.2213	.1108	.1278	.0637	.1448	.0703
% of Total Costs	26.5 32.7	19.9 25.8	33.5 41.3	24.3 32.6	43.8 51.8	31.0 39.5
Wiring Costs, $	.1520	.0632	.07	.035	.0503	.0249
% of Total Costs	18.2 22.4	11.4 14.7	18.4 22.7	12.6 17.0	15.2 18.0	11.0 14.1
Total Equipment Costs, $	.3733	.174	.1978	.0987	.1951	.0952
% of Total Costs	44.6 55.0	31.3 40.5	52.0 64.0	35.6 47.9	59.0 69.5	42.2 54.0
Lamp Costs, $	.1210	.0997	.027	.0222	.022	.0161
% of Total Costs	14.5 17.9	17.8 23.2	7.1 8.7	8.0 10.7	6.7 7.8	7.1 9.1
Maintenance Costs, $	.0271	.028	.0129	.0153	.012	.016
% of Total Costs	3.25 4.0	5.0 6.5	3.4 4.2	5.5 7.4	3.6 4.3	7.1 9.1
Current Load—w./Sq. Ft.	5.777	4.737	2.656	2.607	1.898	1.835
Energy Cost Per Year, $	.312 .156	.2558 .1279	.1434 .0717	.1408 .0704	.1025 .051	.0991 .0495
% of Total Costs	37.5 23.0	46.0 41.7	37.7 23.2	51.0 34.0	31.0 18.2	43.7 28.0
Total Lighting Costs Per Square Foot Per Year	.8334 .6774	.5575 .4296	.3811 .3094	.277 .2066	.3316 .2801	.2264 .1768

*The watts per square foot indicated apply only to the appraisal area which, in the high- and medium-productivity sections, would be incandescent, as indicated by the 2900°K. as the data used for writing this paper was computed before the announcement of the warm-tone fluorescent.

The environmental lighting, which is primarily fluorescent from troffers, pendants, overhanging cornices, etc., is best arrived at on a basis of average footcandles. We arrived at the watts per square foot for displayed stock lighting by carefully examining a number of modern plans for the productivity groups as noted.

Appendix A

Description of columns and symbols: 1, Department or group; 2, Average of small and large store departmental sales % to total store sales; 3, Average productivity (Average annual sales per square foot of sales area); 4, Productivity of large store percentage over average productivity of small store; 5, Classification of average gross sale—H, high; MH, medium high; L, low; 6, Degree of impulse or demand merchandise—H, high degree impulse; MH, medium high; B, balanced between impulse and semi-demand; U, unclassified (see text); D, predominantly demand goods.

Description of Tabulation

Column 1 gives the department or group of departments, and they are listed according to high, medium, and low productivity and also their average location in a department store because, obviously, location has considerable bearing on all productivity.

Column 2 shows the average sales percentage to the total main store; in other words, the total upstairs store exclusive of the basement. These figures are an average of adjusted figures for Controllers' Congress Class III and Class V, or the small and large store previously described.

Column 3 shows the average sales per square foot which is, in a way, a double average. First, we arrived at an average between typical and goal productivity for Class V and an average between typical and goal productivity for Class III, and then averaged these two.

However, Column 4 gives the range in terms that the percentage the average productivity of the larger store is greater than the smaller store. For example, in better jewelry, the smaller store produces an average of $200 per square foot and the larger store can produce $400 per square foot, or 100 per cent greater. Notice that the candy section, which is without question almost 100 per cent impulse, has the greatest spread of any department.

Column 5 indicates the average gross sale, which is the total gross sales divided by the number of transactions.

Column 6 indicates the degree of impulse or demand merchandise. It might be explained that impulse merchandise is that which a customer did not have any intention of purchasing when entering the store; that is, she entered to purchase demand goods, was attracted to the display of the impulse merchandise, and purchased it, thus creating a plus sale. It is obvious that the very large store with the greater density of traffic will produce a higher degree of impulse sales. It is said, for example, that the sales in the variety store today are in excess of 60 per cent impulse sales.

Balanced between impulse and semi-demand merchandise (B) means that in many departments there might be a considerable number of items which might be medium high or high impulse and at the same time there are some items which are demand. For example, in Men's Furnishings, men's neckwear and shirts are impulse, whereas underwear, hats, and some sportswear would be semi-demand.

Unclassified (U) indicates that many well stocked sections, because of seasonal or other demand, act as demand pullers as total departments but, again, many individual items can have a high degree of impulse sales.

Productivity is governed oftentimes by the amount of selection of merchandise that is available to satisfy the customers' demand.

1	2	3	4	5	6
Department or Group	Average Sales % to T. S.	Average Sales Per Sq. Ft.	Range Av. Sales Per Sq. Ft.	Average Gross Sale	Degree Impulse or Demand
HIGH PRODUCTIVITY—Preferred Main Floor Locations					
Leather Goods	1.65	177	63	M	MH
Hosiery	3.1	325	70	L	MH
Toilet Articles	3.05	205	27	L	B
Costume Jewelry	1.4	250	50	M	MH
Better Jewelry	.5	300	100	H	B
Gloves	1.15	202	60	M	MH
Umbrellas	.28	280	25	M	U
Neckwear	1.15	167	48	M	H
Handkerchiefs	.68	180	48	L	H
Total Accessories	12.96	233			
Men's Furnishings	5.35	200	54	M	B
Candy	.86	205	115	L	H
Total High Productivity	19.17				
MEDIUM PRODUCTIVITY—Often Has Main Floor Location or "Second Preferred"					
Notions	1.55	115	56	L	B
Books	.81	102	73	L	MH
Stationery	1.5	142	37	L	B
Silverware	.74	165	100	M	MH
Women's & Children's Shoes	4.35	123	4	M	D
Knit Underwear	1.2	160	66	M	MH
Total	10.15				
MEDIUM PRODUCTIVITY—Has Third Preferred Location—Generally Upper Floors					
Men's Clothing	3.2	115	30	H	D
Men's Shoes	.88	105	34	M	D
Muslin Underwear	2.45	145	41	M	B
Corsets	1.8	130	17	M	D
Negligees	.8	120	18	M	U
House Dresses	1.6	87	33	M	B
Linens	1.95	100	50	M	B
Domestics	1.55	215	130	M	D
Blankets	1.4	105	63	M	D
Total Linens	4.9	137			
Laces	.56	115	30	L	B
Silks	1.7	110	44	M	U
Woolens	.86	140	33	M	U
Wash Goods	1.0	120	40	M	U
Total Yard Goods	3.56	120			
Infants'	3.0	85	38	M	B
Girls'	1.75	70	54	M	B
Boys'	2.15	75	50	M	B
Millinery	2.1	60	40	M	B
Coats	4.35	215	26	H	D
Juniors	2.35	117	13	H	D
Dresses	5.1	110	12	H	D
Sportswear	3.7	105	33	M	B
Furs	1.35	170	13	H	D
Total Ready to Wear	16.85	110			
Total	45.60				
Total Medium Productivity	55.75				
LOW PRODUCTIVITY—Less Valuable Locations					
Appliances	2.3	170	61	H	D
Radios	1.35	140	32	H	D
Luggage	.52	105	68	H	U
Toys	1.5	70	79	M	U
Sporting Goods	.70	55	74	M	U
Furniture	4.95	38	72	H	D
Draperies	3.4	70	33	M	D
Floor Coverings	2.65	63	74	H	D
Lamps	.79	52	62	M	D
Pictures	.29	37	50	M	U
China	1.5	45	57	M	B
Housewares	3.85	65	84	M	B
Gifts	.81	50	22	M	U
Art Needlework	.78	50	20	L	U
Total Low Productivity	25.39				
TOTAL MAIN STORE	100			M	
Basement	8.0 to 14.0	85	84	M	

Design and Illumination Characteristics of Louver and Louverall Systems—Part I

By WENTWORTH M. POTTER
R. L. OETTING

This paper presents the results of an extended study involving approximately 700 tests and 100,000 photometric measurements exploring the effects of a number of variables inherent in the design of louver and louverall systems. The influence of these factors on efficiency and utilization, candlepower and brightness distributions, and appearance, is presented in summary in Part I. More complete data and design charts will appear as Part II in a subsequent issue, together with the contributed discussion.

GREAT INTEREST has become evident during the past several years in the louvered ceiling, or louverall, as a useful architectural device and an effective system of illumination. Numerous examples have dramatized the possibilities of the technique and have given impetus to further commercial development. They have stimulated increased interest in the technical, economic and appearance aspects of louvering in general, whether for individual luminaires or for more extended elements.

Large louvered elements constituting a large part of the ceiling were described as long ago as 1932. In that year, one designed primarily for decorative pattern was installed in a theatre lobby[1]; another, with large curved and radial blades, was reported in 1936.[2] In 1939, a louverall type of installation with fluorescent lamps was made in the Lighting Institute at Nela Park. Recently, particular interest has been shown in louver systems which are essentially co-extensive with the room itself and which, in effect, estab-

A paper presented at the 1948 National Technical Conference of the Illuminating Engineering Society, September 24, 1948, Boston, Massachusetts.

MR. POTTER and MR. OETTING are with the Engineering Division, Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.

(Facing Page)

Figure 1 A. Showroom and offices of Nash-Kelvinator Corporation, Chicago. Eppenstein and Schwab, Chicago, Architects. White louver cells 4" square, 3" deep; shielding angle 37°. Rows of 40-watt T12 fluorescent lamps 15" on centers 11" above grid. Supplementary lighting, fixed and adjustable Reflector and Projector lamps.

(Bottom)

Figure I B. Claudette Candy Shop, Detroit, chartreuse-tinted louverall. Cells hexagonal, 3⅜" across, 2¼" deep; shielding angle, 34°. Lamps, 40-watt T12 in reflectors, 18" above grid; rows spaced about 12". Initial illumination, 85-90 ft-c. Twelve 150-watt Reflector lamps above grid highlight counters.

(Center)

Figure 1 C. Drafting room, Coleman Stove Co., Wichita. Translucent plastic cells, 2" square, 2" deep; shielding angle, 45°. Lighting, RLM Reflectors, 18" above grid, two 40-watt T12 fluorescent lamps each, rows 3' apart. Initial illumination, 123 ft-c.

(Upper)

Figure 1 D. Distinctive louverall section in the Sample Shop, Buffalo. Designer, Leo Fischer, Newark, New Jersey.

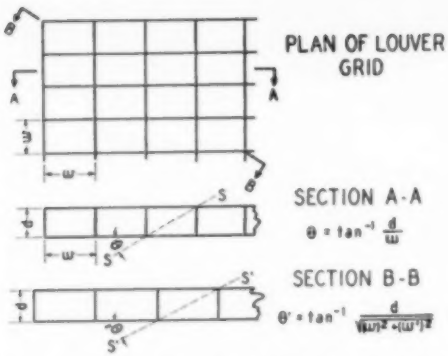


Figure 2. For rectangular cells, louver shielding angles (θ) perpendicular to louver blades or θ' along the cell diagonals are determined from simple trigonometric relationships.

lish new ceilings. They have come to be described as "louverall."

Architects have recognized that louverall ceilings approach the goal of an environment with no obvious source of illumination. Perkins and Will suggested such a treatment for schoolrooms in 1945. Among the 1946 installations were those in the United Nations Auditoriums at Lake Success (Walker, Foley & Smith); the Florsheim Shoe Store at 47th Street and Fifth Avenue, New York (Ketchum, Gina and Sharp); the TWA Ticket Office in Chicago (Merrill, Skidmore and Owings); and the director's office in the General Electric Lighting Institute (Wilbur D. Riddle). They have been extended generally into stores, offices, drafting and conference rooms, lobbies, banks, schools, museums, bars and restaurants. Examples of some of the techniques employed are illustrated in Fig. 1.

Louvers and baffles have long been applied to filament downlights and show window reflectors to afford direct light emission while obscuring source and reflector brightness at the angles of usual view. Various aspects of this method of light and brightness control have been discussed in the literature on luminaire design.[4,5,6] It was employed very early in the development of luminaires for fluorescent lamps.[7] The inherently lower brightness of these sources reduced the need of diffusing media beneath, while the dimensions and output generally dictated the use of many luminaires of considerable size. Depreciation and maintenance accordingly assumed increasing importance in illumination design and the selection of luminaires. Vertical louvers and baffles came into extensive use because they did not collect dust and dirt rapidly and caused but moderate losses in illumination when soiled. Luminaires of this type predominate today.

Some comparative measurements of louvers and other methods of shielding have been reported.[7] However, no systematic and comprehensive evaluation of the effects of the numerous variables in the design of such systems has been available so that the design of most louverall systems has been on a cut-and-try basis. Actually, designers of louverall are creating a new ceiling as well as a large luminaire. They use standardized or custom-built components with great latitude in arrangement. The problem is to predetermine pattern or appearance, illumination and brightness values.

Appearance enters into all designs. In some, uniformity of brightness will be a goal while in others some variation will lend interest. Again, low louver brightness may be especially desired. Optimum initial efficiency will be indicated for certain installations, but it will be secondary to

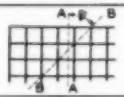
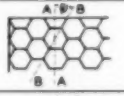
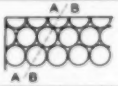
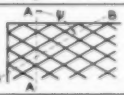
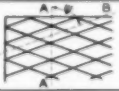
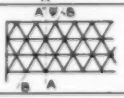
CELL PATTERN	ASSUMED θ IN A-A	MINIMUM θ' IN B-B	ANGLE Ψ
	SQUARE		
	45°	35°	45°
	SINE WAVE		
	45°	55°	45°
	HEXAGON		
	45°	41°	30°
	CIRCLE		
	45°	45°	—
	DIAMOND (60° APEX)		
	45°	45°	60°
	45°	30°	90°
	DIAMOND (40° APEX)		
	45°	34°	70°
	45°	20°	90°
	TRIANGLE		
	45°	41°	30°

Figure 3. Shielding angles (θ) on the diagonal or through the longest dimensions of cells are often smaller than the nominal value at right angles to blades or across the pattern, as in the case of diamonds.

present and future flexibility in others. Variables which must be co-ordinated to achieve the desired result are identified in Part I of the paper. Quantitative effects of each are indicated in the Summary.

The Louver Grid

The louver itself is of primary importance architecturally and decoratively. The size and pattern of cells, their shielding angles, and the texture, reflectance and transmittance of blades may be varied to achieve the desired result.

Pattern and Size. Cell pattern and size should be harmonized with the scale and character of other elements of the interior. The illustrations indicate something of the range of cell patterns which is available to the designer. The possibilities are almost limitless and no doubt many others will be evolved and developed for practical application.

In the judgment of many, the smaller one-inch to three-inch cells characteristic of individual luminaires provide a texture which is acceptable in most types of interiors even when used in large panels or wall to wall. Most of the standardized louverall grids have two-inch to four-inch cells, although much larger sizes have been used in specialized or custom-built installations. Larger cells tend to become architectural elements in their own right and seem particularly appropriate in rooms of modern, functional design.

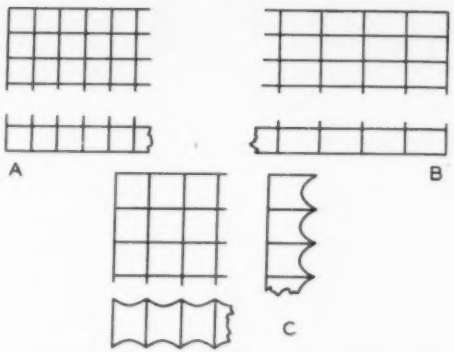


Figure 4. Square cells providing differential lengthwise and crosswise shielding and rectangular cells providing equalized shielding are illustrated in A and B. They employ lengthwise blades of a depth different from that of the crosswise. Two methods of varying blade depth to get equalized shielding for all reference directions are seen in C.

Shielding Angle. Equally important in every louver system, large or small, is the shielding angle. This characteristic is defined as the angular distance below horizontal within which all objects above the grid are obscured (Fig. 2). In selecting shielding angle, consideration must be given both to brightness control and to concealment of lamps and objectionable objects or surfaces above the grid. Experience indicates that angles of less than 40° afford insufficient concealment. Increased shielding also reduces average brightness in the shielded zones, a factor which is often important due to the large area involved in louverall installations. Shielding angles of 45° or higher are indicated for offices, schoolrooms and other areas where a comfortable environment is desired for continued visual work.

In some merchandising areas, compromise is made between concealment and efficiency of output and illumination of vertical surfaces. With smaller shielding angles, a greater output and wider distribution of light is obtained. However, where intrusion of light sources and other cavity details are to be minimized, shielding angles of 40° - 45° or even higher should be selected. In museums, angles in excess of 50° have been chosen in several instances. Concealment is complicated in these areas because normal viewing directions may be somewhat above the horizontal, which is less true in the other applications mentioned. As indicated in Fig. 3, the nominal shielding angle is usually the maximum and lower values may apply for certain orientations of the

Figure 5. Office, Lighting Institute, Nela Park. Wood cells progressively larger toward walls preserve minimum lamp-shielding angle of 45°. Sixty-four 40-watt T17 low brightness lamps mounted on crosswise channels. Maximum illumination, 180 ft-c.

observer. Methods of obtaining uniform shielding in all directions are suggested in Fig. 4.

In many instances, differential shielding provides distinct advantages. In a long, narrow store, for instance, with rows of lamps parallel with the length of the space, fairly deep lengthwise shielding might be selected to conceal the sources, while less shielding crosswise would provide increased efficiency, good vertical illumination, reasonable comfort and satisfactory appearance. Similar considerations may apply for hallways, auditoriums and other areas where the direction of view is restricted by the dimensions or use of the space.

Similarly, the shielding may vary with the location of a louver element or segment. Thus, the shielding of luminaires in the direction of adjacent walls may often be reduced or omitted. An example of such variable shielding is shown in Fig. 5. Around the perimeter of an area, tilted blades can be incorporated to enhance vertical illumination.

Reference to Fig. 6 shows that the shielding angle crosswise a light source may be greater than the nominal shielding value of the louver grid. This is true only when the bulb diameter is small in comparison to the size of the louver cells.

Thus, suitable co-ordination of lamp position, lamp diameter and louver blades will improve efficiency (for a given lamp shielding), or affect increased lamp shielding, or both. The method is, however, more applicable to individual luminaires than to louverall since it limits the flexibility of lamp position and may reduce concealment of objects other than lamps. Few luminaire designers have taken advantage of such co-ordination.

The method is illustrated in Fig. 7b. The lower edges of blades parallel with the lamps are established by the intersection of planes at the desired shielding angle and tangent to the lower arcs of adjacent lamps. A plane from any of these lower blade edges and tangent to the upper arc of the second lamp beyond establishes the top edges of the louvers. The grid in this illustration has a crosswise shielding angle of 25° (θ), but the lamps are shielded to 40° (φ). In practice, the design must allow some tolerance for inaccuracies in lamp mounting, but the very considerable gain in efficiency of design B over the 40° louver grid of design A is apparent.

Blade Reflectance and Transmittance. Highest output efficiency consistent with suitable appearance, concealment and brightness control is always desirable. In general, this requires high reflectance in the case of opaque louver blades or a high combined value of reflectance and transmittance with translucent materials. In the latter instance, transmittance is usually the more potent factor.

Very low brightness in the shielded zone is available by reducing the reflectance of opaque mat louver finishes. The reduction in efficiency is substantially less than that in brightness. By the same token, brightness increases more rapidly than efficiency as the louver reflectance is increased.

Blade Finish and Texture. Appearance generally determines the texture of louver blade surfaces. Although some gains in efficiency are available with gloss and spread reflecting finishes, where visual comfort is of primary importance, matt finishes are indicated to eliminate bright images and to reduce average grid brightness. Specular or semi-specular finishes will produce source images superimposed upon the louver brightness developed by interreflection. These first reflections are seen in cells beyond the light source and accentuate any non-uniformity of brightness pattern. Shiny black or specular metal blades develop an apparent transparency which may have definite decorative value. However, such blades will image other objects in the cavity above the louver grid. Materials of spread reflection characteristics, such as etched aluminum, produce pleasing brightness gradients.

In many respects, transmitting blades produce results similar to those obtained with reflecting materials of fairly high specularity without the limitation of unwanted reflections. Unless transmitting materials are of very low diffusion, dis-

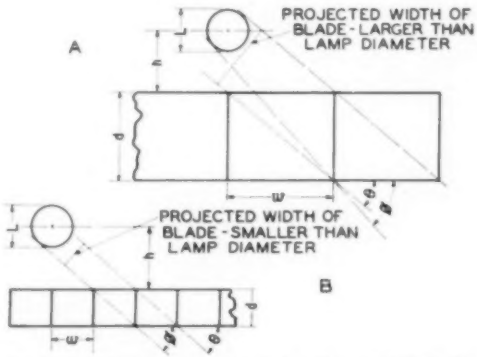


Figure 6. When the ratio L/w is less than sin θ as in A, the projected width of blade exceeds L, and o may exceed # for certain lamp positions and values of *h*. When the ratio is equal to or less than sin θ, the projected blade width cannot exceed L and o equals # for all values of *h*.

tinct source images are not likely to be apparent.

The texture of blade finish should be selected with a thought to maintenance. It should not collect dust and dirt readily and should permit easy washing or wiping. Other desirable attributes include resistance to scratching, discoloration, deterioration of reflectance, and warping. Construction should be such as to result in rigid, sturdy sections which are either readily maintained in place or, preferably, will withstand removal for maintenance.

Cavity and Reflectors

The space or cavity above the louver grid may vary or be varied in several respects. The proportion between depth and width will affect efficiency and utilization. These values will be lower for a large ratio of depth to width than for smaller ones. Two cavities of the same proportion will evidence about the same efficiency even though actual dimensions are greatly different.

Reflectance. Designers of louvered luminaires generally employ high reflectance finishes for not only the louvers but also for the supplementary reflecting surfaces. In larger louvered elements, or in a complete louverall ceiling, it is equally important that the architect, engineer or designer specify high reflectance finishes for all surfaces above the louver grids. Some have erroneously felt that dark finishes better conceal light sources and other objects within the cavity. Low reflectance involves marked reductions in efficiency and a waste in both initial investment and operating expenditure. Concealment of objects in the cavity space can be accomplished through adequate shielding at a substantially lower loss.

When cavity surfaces are made a significant source of diffuse reflected light, the uniformity of louver brightness is improved. As a corollary, high cavity reflectance permits higher lamp-spacing ratios for a given range of brightness. It also minimizes the brightness difference between light sources and their background, with the result that sources are less obtrusive whether viewed directly or observed as reflected images.

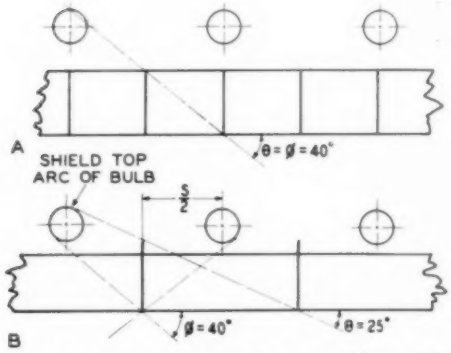


Figure 7. For a constant value of θ (lamp-shielding angle) higher output efficiency can be had with lamps centered between blades, as this permits a relatively shallower louver.

Reflectors. When cavity spaces are badly obstructed, the use of efficient reflectors may materially improve results. Under these conditions, even widespread reflectors direct more light to the louver grid. An unobstructed cavity of equivalent reflectance should be slightly more efficient without such reflectors although their use may be of some advantage from the standpoint of minimized maintenance.

Moderately and highly concentrating reflectors are of value in producing a given illumination with reduced average louver brightness. If only enough lamps are employed to produce a moderate illumination level, lamps and reflectors must be mounted well up in a deep cavity or else nonuniformity of louver brightness must be accepted. Concentrating reflectors are highly useful in directing light through louver grids to designated areas such as school chalkboards, library stacks, elevated drafting boards, counters, show windows and shelf displays. For situations in which an asymmetric or directional distribution of light is desirable, tilted louver blades parallel to the lamps offer a logical solution.

Light Sources

There is a wide range of choice in light sources, in their position above the louver grid, in their relation to individual blades, and in their spacing. Lamp selection is made on the basis of total light output and also for output per unit length and brightness. The latter is particularly important from the standpoint of reflections in shiny objects below and of the brightness of reflected images in gloss blade surfaces.

Lamp Position. In general, efficiency of light output is affected to only a minor extent by the lateral position of lamps with respect to louver blades. Some gains over random positioning may be obtained by placing lamps close to and centered above louver blades. In contrast, when lamps are placed well above the grid, lateral position has no effect upon output efficiency. In extended grid systems with adequate space above, the lamp-to-louver dimension h also has little effect.

Spacing Ratio. Brightness variations over each blade and the difference in brightness between adjacent blades impart texture to the louver grid. Super-posed on these variations are the pattern-

producing ones determined by the lamp-spacing ratio S/h. The larger the ratio, the greater the range of brightness; the importance of lamp-to-louver distance is obvious. Reduced cavity reflectance accentuates the brightness pattern for a given lamp-spacing ratio. These effects are illustrated in the pictorial chart (Fig. 8) at two angles of view for selected louvers. Reasonable uniformity of brightness is obtained with $S/h = 1.5$. When lamps are spaced close together and near louvers of relatively large cell pattern, a larger ratio may be satisfactory since light from each lamp reaches one or two adjacent rows of cells.

Extent of Louver System

As the total light-emitting area of any system is increased, the average brightness of the luminous section will be reduced for a given illumination level. Therefore, a basic advantage of larger louvered elements lies in the increased comfort which results from the lower luminaire brightness within the visual field. The limit is a louverall grid which is co-extensive with the space to be lighted. Some idea of the effectiveness of varying the extent of the system may be had from these comparisons: Assuming the average brightness in the shielded zone of a 3-lamp 12-inch louvered troffer is 100 per cent, that of a 24-inch troffer, which is otherwise comparable, will be a little more than 50 per cent (trapping of light and temperature effects will be reduced), and that of louverall with lamps on 24-inch centers will be only 20 per cent or less. In many cases, the brightness of a louverall ceiling may be made comparable to that of tasks (having moderate to high reflectance) which it is lighting.

In some cases, notably in stores, a relatively bright and lively ceiling pattern may be indicated, when other considerations may call for a louverall installation. Brighter sections may be accomplished by insertion of troffers or by the construction of limited cavities containing more closely spaced lamps. The variation may also include a change in cell size and pattern. Available louver sections will be useful not only in complete louverall systems but will offer many possibilities as large-scale, multiple-lamp troffers. They permit wider lamp spacing than narrower units with reduced temperature, light interception and average brightness.

From the photometric standpoint, there is no difference between small louvered elements or luminaires and a complete louverall ceiling with a similar louver. The individual units may be

Table I. — Comparison of Coefficients of Utilization

A. Calculated for Individual Elements Spaced Conventionally for Uniform Illumination

Louver: cell size, 3" x 3"; shielding angle, 40° x 40°; finish, gloss white; reflectance, 75%.
Cavity: depth to width ratio, 0.056; reflectance, 75%.
Efficiency: for above with T8 lamps and channels, random positions with respect to blades, 47.4%. Proportion of output in 0°-40° zone to that in 0°-90° zone (Flux Ratio), 57.7%.

Ceil. Refl.	75%			50%			30%	
Wall Refl.	50%	30%	10%	50%	30%	10%	30%	10%
Room Index								
J	.26	.24	.23	.26	.24	.23	.25	.23
I	.32	.30	.29	.31	.30	.29	.29	.28
H	.34	.33	.32	.33	.32	.32	.32	.31
G	.36	.35	.35	.36	.35	.34	.34	.34
F	.38	.37	.36	.37	.36	.35	.36	.35
E	.40	.39	.38	.39	.38	.37	.38	.37
D	.42	.41	.40	.41	.40	.39	.40	.39
C	.43	.42	.41	.42	.41	.40	.40	.40
B	.44	.43	.42	.43	.42	.41	.41	.41
A	.45	.44	.43	.44	.43	.42	.42	.41

B. Calculated for Wall-to-Wall Louverall Systems.

Ceil. Refl.	75%		
Wall Refl.	50%	30%	10%
Room Index			
J	.21	.18	.17
I	.25	.21	.20
H	.27	.24	.23
G	.30	.27	.25
F	.32	.29	.27
E	.34	.31	.30
D	.36	.33	.32
C	.37	.34	.34
B	.38	.36	.36
A	.39	.37	.37

Louver: cell size, 3" x 3"; shielding angle, 50° x 50°; finish, mat white; reflectance, 75%.
Cavity: depth to width ratio, 0.23; reflectance, 75%.
Efficiency: for above with T8 lamps and channels, random positions with respect to blades, 34.6%. Proportion of output in 0°-40° zone to that in 0°-90° zone (Flux Ratio), 59.6%.

Ceil. Refl.	75%			50%			30%	
Wall Refl.	50%	30%	10%	50%	30%	10%	30%	10%
Room Index								
J	.19	.18	.17	.19	.18	.17	.18	.17
I	.23	.22	.22	.23	.22	.22	.22	.21
H	.25	.24	.24	.25	.24	.24	.24	.23
G	.27	.26	.26	.26	.26	.25	.25	.25
F	.28	.27	.27	.27	.27	.26	.27	.26
E	.29	.29	.28	.29	.28	.28	.28	.27
D	.31	.30	.29	.30	.30	.29	.29	.29
C	.32	.31	.30	.31	.30	.30	.30	.29
B	.32	.31	.31	.31	.31	.30	.30	.30
A	.33	.32	.32	.32	.31	.31	.31	.30

Ceil. Refl.	75%		
Wall Refl.	50%	30%	10%
Room Index			
J	.16	.13	.12
I	.18	.16	.15
H	.20	.18	.17
G	.22	.20	.19
F	.23	.21	.20
E	.25	.23	.22
D	.26	.24	.24
C	.27	.25	.25
B	.28	.26	.26
A	.29	.27	.27

considered as discrete elements of the larger system or the louverall ceiling may be regarded as an assemblage of conventional luminaires. Comparable elements of each will exhibit identical distribution and, within reasonable limits, similar output efficiency.

Utilization

Tables of utilization data developed for conventional luminaires do not apply to louverall because of differences with respect to:

1. The effective ceiling reflectance, and
2. The placement with respect to walls.

In regard to the first, two appraisals are significant. In the basic data of Harrison and Anderson,[9] the effect of ceiling reflectance on utilization for luminaires directing all light downward is a minor one. For a room with walls of 50 per cent reflectance and a room-dimension ratio of 5.00 (Room Index A), an extreme change from 75 per cent to 0 per cent ceiling reflectance lowers the utilization factor only 7 per cent for a narrow-classification, direct-lighting output. For smaller room ratios, the difference is even less.

It is possible to estimate the effective ceiling reflectance of a louverall installation fairly closely. From a group of tests with 6-inch x 6-inch, 40° louvers in a cavity having a depth 0.056 of the width, the various direct and reflected components of light output have been isolated. Of the light entering a louverall system from the room below, about 54 per cent is reflected back into the cavity by the soffit if louver and cavity reflectance is 75 per cent. The effects of interreflection are so complex that the percentage of this component which is re-emitted into the room cannot be determined precisely from the test data. It is approximately 40 - 45 per cent, however, which indicates an effective reflectance of 20 - 25 per cent for systems of the above specifications. Factors which affect the output efficiency will influence the effective reflectance of the system and, to some extent, the utilization.

The second difference peculiar to louverall is more powerful. When individual louvered elements of the size of conventional luminaires are spaced in accordance with usual practice, coefficients of utilization calculated from the basic data of Harrison and Anderson are applicable. But the net utilization for an entirely luminous ceiling of similar candlepower distribution will be somewhat less.[10] The source of the difference becomes apparent when two extremes of element placement are considered. The utilization of a single small element centered in the ceiling of a room is relatively favorable, but becomes less so when the unit is placed adjacent to a wall or in a corner. The walls intercept about 50 per cent to 75 per cent of the light under these conditions, and the utilization of light is reduced accordingly. This is the situation with respect to the peripheral sections of louverall systems. Table I indicates the order of the difference in coefficient for two examples.

Flexibility

One of the most appealing features of extensive louverall systems is their adaptability to future changes in illumination or to re-arrangement of light sources to conform with changes in use of space. With an extensive grid and suitable space or cavity above, comparatively simple additions of sources and accessories suffice to increase the illumination values with, of course, an increase in brightness of the affected louver sections. Rows of lamps may be non-uniformly disposed above a large grid, so that light is distributed to better advantage for seeing purposes. Examples are found in schools — to balance illumination received from both daylighting and the electric lighting systems — and in some stores — to provide higher illumination in certain selling areas. With adequate cavity space, addition of supplementary lighting systems such as filament downlighting is often feasible.

For merchandising, adjustable angle spotlighting is often needed on displays in conjunction with the general lighting from the louver system. Since the louver grid will usually decrease the effectiveness of a tilted spotlight above, some manufacturers are making provision for insertion of such units into the grid itself.

The possibilities of color are great; tints may be employed for the louver blades to achieve subtle decorative effects without substantial modification of the emitted light. Moreover, combinations of color and white lamps may be used to produce color patterns in the louver grid with control of the spectral quality of the total flux. Many other variations will suggest themselves to the resourceful designer.

Reflected Images

The reflection of louver systems in shiny surfaces produces highlights which may be annoying. The more extensive the system, the more difficult it is for the eye to avoid these images. Reflections veil merchandise in unlighted glass cases and result in objectionable patterns on automobiles, some furniture and silverware, and similar polished finishes. The effect is most noticeable when the objects are dark-colored. Images in shiny surfaces near or a part of office, school

and factory tasks are annoying and interfere with seeing. In the office and school fields, matt surfaces of relatively high reflectance are recommended because they minimize interference from reflected glare. So, too, do low-brightness sources and low-brightness ratios within the louver system.

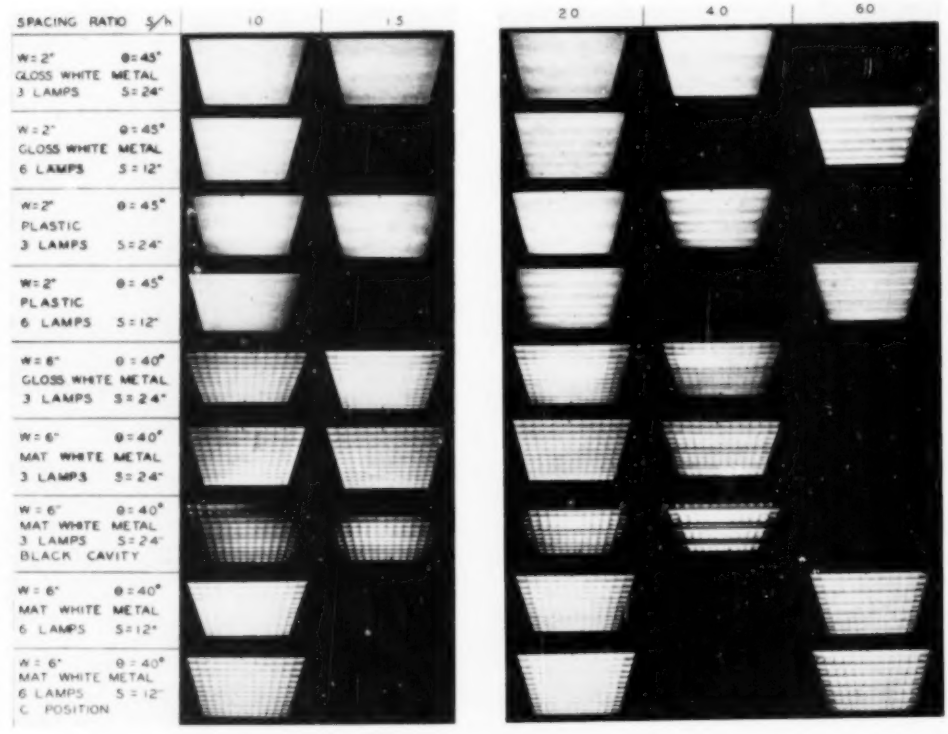
Tilted blades can provide an unusual degree of freedom from reflected glare. In 1932, Shoemaker described the use of tilted louver blades to eliminate annoying reflections for drafting.[11] He employed a large element consisting of parallel blades $2\frac{1}{2}$ inches wide and $1\frac{1}{4}$ inches apart and tilted 20° from the vertical away from the worker. Above were tubular sources to minimize shadows crosswise of the drafting table.

A louverall installation in which movable blades in one direction may be tilted up to 45° has been made at Nela Park (Fig. 9). From it, basic data on the causes of reflections and methods of eliminating them have been obtained. Harrison has reported his observations as follows:[12] "... results seem distinctly superior. It is our belief that with such a system, there is almost no top limit to acceptable levels of artificial illumination." Tilted blades also afford interesting possibilities in directional or asymmetric light distributions for illuminating vertical or oblique surfaces.

Cost Considerations

The initial cost of louverall is likely to be higher than that of more conventional lighting equipment. Exceptions are frequently found, however, when high values of illumination, high orders of seeing comfort, or low-brightness lamps are to be provided. With louverall, low-brightness sources may be used at a small differential in cost because there is no attendant increase in number, size and cost of luminaires, except the relatively low cost of added channels. When louverall is employed as both a lighting system and decoration — or a treatment to hide unsightly obstructions — the cost, relative to a combination of other types of lighting and ceiling treatment, may be equal or even less. If an architec-

Figure 8. Below and on facing page is shown typical variation in texture and brightness pattern found with selected combinations of louver, lamp spacing and spacing ratio and cavity reflectances. Left views taken at 5° above louver cut off angle; right at 15° from plane of louver grid. (w = cell width).



tural problem involves the creation of a ceiling to conceal ducts, pipes, sprinklers and similar obstructions, louverall, designed with adequate shielding, will, in itself, often accomplish this objective with important savings.

Summary of Test Results

In designing or appraising louver systems, primary considerations include:

I. *Output Efficiency and Utilization*

1. *Shielding Angle* — Output efficiency changes nearly one percentage point per degree for square white cells. With crosswise shielding fixed at 40°, efficiency changes about one-third point per degree of differential lengthwise shielding. Utilization changes more slowly because candlepower distribution becomes narrower as shielding angle increases.

2. *Reflectance of Blades and Cavity* — These values radically affect efficiency and utilization. With 40° square white cells and a shallow cavity, relative efficiency is:

100 per cent for 75 per cent blade reflectance and 75 per cent cavity reflectance

48 per cent for 4 per cent blade reflectance and 75 per cent cavity reflectance

46 per cent for 75 per cent blade reflectance and 4 per cent cavity reflectance

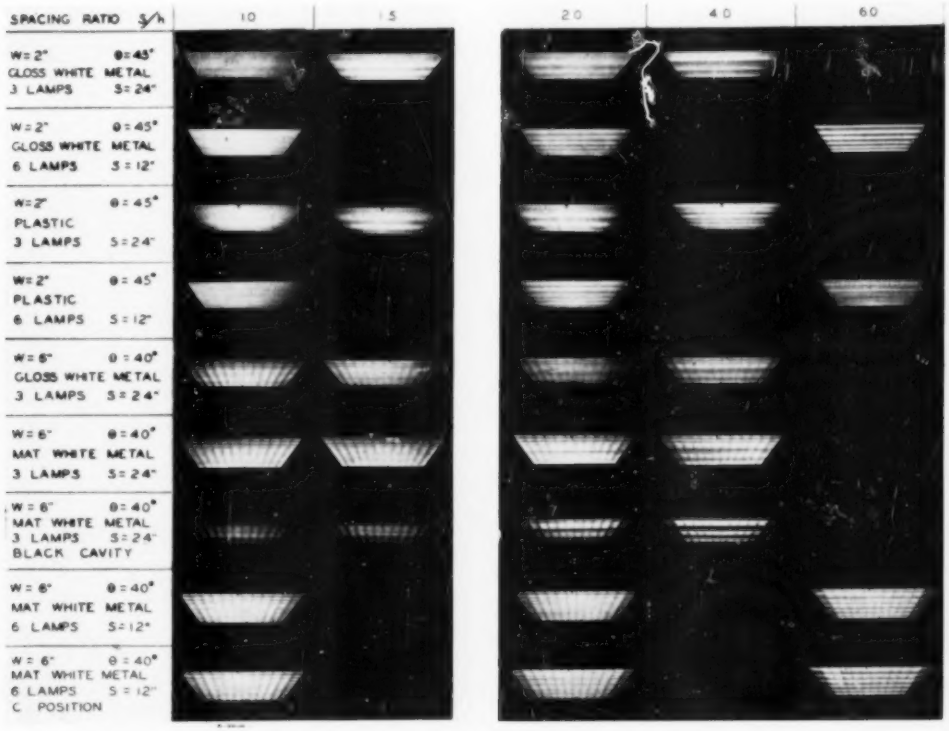
24 per cent for 4 per cent blade reflectance and 4 per cent cavity reflectance

For deeper cavities, relative values are lower. Utilization varies in about direct proportion with efficiency for changing cavity reflectance. Louver reflectance modifies candlepower distribution and utilization changes less than efficiency.

3. *Blade Finish* — Spread and specularly reflecting finishes produce higher efficiency than matt (gloss white tested was 5 - 7 per cent higher than matt of equal tonal reflectance).

4. *Transmittance of Blades* — Tests indicate that greater efficiency accompanies increased transmittance. Utilization increases less. One plastic louver showed efficiency 45 per cent higher than for similar matt white metal.

5. *Cavity Cross-Section* — Proportionality of depth to width, not actual dimensions is important; efficiency for cavity proportionality of 0.347 is 88 per cent of that for 0.056 cavity. Distribution change is slight; utilization changes are about directly proportional to efficiency.



6. *Individual Reflectors* — Little difference in efficiency and still less in utilization was found for diffuse white reflectors as compared with a cavity of equal reflectance. Their use may be advantageous in badly obstructed cavities, or from the standpoint of minimized maintenance. Moderately to highly concentrating reflectors above matt white louvers increased efficiency 11 - 32 per cent and utilization 12 - 45 per cent as compared with an open white cavity. Gains were somewhat smaller for gloss white and transmitting blades.

7. *Cavity Obstructions* — These trap light and reduce efficiency. Addition of channels and five lamps lowered output and utilization 6 per cent from single lamp.

8. *Cell Dimensions* — Little effect for given shielding. Efficiency and utilization of two-inch cells about 95 per cent of that for six-inch cells.

9. *Extent of Element* — This has no significant effect on efficiency. Utilization will be lower for wall-to-wall louverall than for normally-spaced individual elements. The difference varies with candlepower distribution (5 - 6 percentage points for 40° white louvers, 3 - 4 points for 50° cells) and is due to greater interception by walls of light from peripheral elements of the louverall system.

10. *Lamp Position* — For relatively large cells, efficiency gains of 5 - 7 per cent realized by centering lamps close to and directly above louver blades as compared to random position.

11. *Lamp Distance Above Grid* — No effect on output if cavity proportions are fixed and reflectances are about 75 per cent. Moving lamp upward causes gradual reduction with lower reflectances.

12. *Lamp Diameter* — Effect on efficiency and utilization is negligible with lamps placed in random positions or high above the louver. It is a factor in the design of co-ordinated lamp and louver systems if lamp shielding is to be significantly greater than the louver shielding angle.

II. *Quality of Lighting-Brightness* — (Comparisons apply for average of all directions of view at 15° from plane of grid unless otherwise stated.)

1. *Shielding Angle* — The average brightness in the shielded zone increases at a rising rate with reduced shielding; if the brightness of square mat white cells of 50° shielding is 100 per cent, it is 146 per cent at 35° and 229 per cent at 20°. Matt white cells have about the same brightness in all directions. If lengthwise shielding angle only is reduced, the brightness seen lengthwise increases rapidly; crosswise, slowly.

Figure 9. Experimental installation at Nela Park to evaluate effect of tilted blades in reducing or eliminating reflected glare. Fixed vertical wood blades provide lengthwise shielding of approximately 45°. Tilting metal blades parallel with lamp rows are spaced 4" apart horizontally and may be tilted as much as 45° to provide concealment at nadir.

2. *Reflectance of Blades and Cavity* — Brightness and efficiency change about equally with cavity reflectance, but brightness changes much faster than efficiency with louver reflectance. Variations in louver shielding and louver reflectance or use of reflectors are preferred methods of brightness control.

3. *Blade Finish* — Gloss white louvers average brighter than matt; the increase is more marked near horizontal and with crosswise view of lamps. Specularity causes well-defined bright images in shielded zone. Spread and specular surfaces magnify effect.

4. *Transmittance of Blade* — Brightness increases appreciably; with high transmission may be double (for equal lamp lumens) or 40 - 50 per cent higher (for equal illumination) than brightness of opaque, matt-white blades.

5. *Individual Reflectors* — The more concentrating the reflector, the lower the average louver brightness. For the same illumination, an etched reflector reduced brightness 22 - 32 per cent while a specular reflector reduced it 29 - 35 per cent below that with a white cavity only. Both concentration and efficiency of reflectors influence such comparative results.

6. *Cavity Cross-Section* — For equal illumination and 40° shielding, average louver brightness is 6 - 7 per cent less if cavity depth is one-third the width rather than 1/18. In general, additional lamps or the introduction of channels cause changes proportional to efficiency.

7. *Extent of Louver Element* — No effect at the same loading of lamp lumens per square foot. Large size permits low loading — a basic advantage of louverall.

8. *Angle of View* — As viewing angle with plane of grid is reduced, brightness decreases in all cases. Thus, more distant elements nearer the usual line of vision will be of lower brightness than those nearby.

9. *Reflected Glare* — Depends primarily on source brightness. For specular surfaces, low-brightness sources and low-brightness ratios within system are desirable.

III. *Appearance—Brightness Pattern and Texture*

1. *Cell Dimensions* — Relation to scale of room and appointments is major consideration. Small cells are useful for developing texture, large ones for pattern.

2. *Shielding Angle* — Higher angles emphasize texture due to brightness variation from top to bottom of blades and between adjacent blades; provide more complete concealment of objects within cavity.

3. *Spacing Ratio* — The smaller the ratio of lamp spacing to height above the louvers, the more uniform the brightness pattern. About 1.5 represents typical choice for reasonable uniformity. Sometimes moderate variations in brightness lend desirable interest.

4. *Blade Finish* — Spread or specular finishes impart pattern due to highlights occurring beyond lamp position.

5. *Reflectance of Blades and Cavity* — Low cavity reflectance emphasizes brightness variation or pattern. Gloss-finished blades of low reflectance produce high contrasts and an effect of transparency.

6. *Transmittance of Blades* — Tends to flatten texture of individual cells but, with low diffusion, will often emphasize over-all pattern.

7. *Individual Reflectors* — The more concentrating the reflector, the more marked the pattern of brightness for a given spacing ratio; reduction in ratio for given uniformity generally is not great.

8. *Cavity Cross-Section* — The deeper the cavity, the greater the latitude in lamp spacing for a given uniformity of brightness.

9. *Angle of View* — A pattern of varying brightness is most pronounced at small angles of view from the plane of the louver grid; hence, at greater distances in larger rooms.

10. *Color of Sources* — By employing sources of two or more colors, in proportions to provide illumination of desired spectral characteristics, interesting decorative patterns may be achieved with relatively high uniformity of brightness.

Bibliography

1. Light in Architecture and Design, Paramount Theatre, Oakland, Calif., *Transactions I.E.S.*, Vol. XXVII, p. 350 (1932).

2. Light and Architecture, Hotel Sinton, Cincinnati, Ohio, *Transactions I.E.S.*, Vol. XXXI, p. 652 (1936).

3. Park Ridge Schools, by Lawrence B. Perkins, Architect, *Magazine of Light*, Vol. 17, p. 1-22 (1948).

4. Louvered Lighting, by J. L. Stair and L. H. Graves, *Transactions I.E.S.*, Vol. XXXI, p. 249 (1936).

5. Control of Light with Louvers, by W. E. Folsom, *Transactions I.E.S.*, Vol. XXXII, p. 734 (1937).

6. Engineering Aspects of Direct Lighting, Part I — Louvered Systems, by J. M. Ketch and G. R. LaWall, *Transactions I.E.S.*, Vol. XXXIII, p. 545 (1938).

7. The Design of Luminaires for Fluorescent Lamps, by W. M. Potter and W. G. Darley, *Transactions I.E.S.*, Vol. XXV, p. 759 (1940).

8. Louvered Ceilings—A New Lighting Technique, by Charles L. Amick, *Electrical Construction and Maintenance*, August 1947.

9. Coefficients of Utilization, by Ward Harrison and Earl A. Anderson, *Transactions I.E.S.*, Vol. XV, p. 97 (1920).

10. Illumination Distribution From Surface Sources in Rooms, by H. H. Higbie, *Transactions I.E.S.*, Vol. XXXI, p. 163 (1936).

11. Synthetic Lighting, by George E. Shoemaker, *Transactions I.E.S.*, Vol. XXVII, p. 308 (1932).

12. Some Frontiers of the Lighting Art, by Ward Harrison, *Transactions I.E.S.*, (Great Britain), Vol. XIII, p. 121 (1948).

13. Effect of External Factors on Light Output of Fluorescent Sources, by J. C. Forbes and R. J. Diefenthaler, *ILLUMINATING ENGINEERING*, Vol. XLI, p. 872 (1946).

Third International Lighting Exposition to Assemble "Tools of the Trade" for Lighting Engineers

R. W. Staud

By RUDOLF W. STAUD

CHAIRMAN, COMMITTEE ON ATTENDANCE, PROMOTION AND PUBLICITY
THIRD INTERNATIONAL LIGHTING EXPOSITION

The well-known saying that "a workman is no better than his tools" applies with equal force to the lighting engineer.

Let us consider for a moment what *are* the lighting engineer's "tools." A little thought will bring us to the realization that his "tools" must of necessity be the various kinds and types of lighting equipment which he installs.

"Tools" the Final Test. This brings us to the inevitable conclusion that no matter how talented or how well-trained a lighting engineer may be, his work will still be judged, to a large degree, by his "tools"—the fixtures and lamps and other equipment he uses.

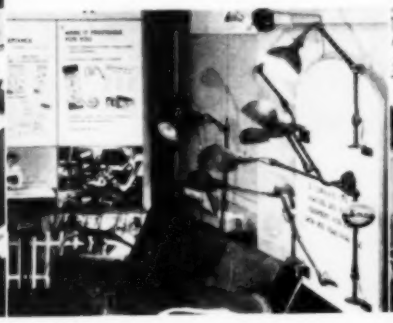
So it would seem that keeping himself informed on the very latest in lighting equipment is one of the most important things that a lighting engineer can do. In fact, it is with this very purpose in mind that each year an increasing number of lighting engineers are attending events such as the Third International Lighting Exposition and Conference, which will be held March 29 through April 1, 1949 at the Stevens Hotel, Chicago.

Truly International in Scope—The Third International Lighting Exposition and Conference is an event world-wide in scope and attendance, with 10,000 Planned-Lighting-minded visitors expected from all parts of the globe. Representatives of many business groups from foreign nations have already signified their intention to be present. This is in addition to the many thousands of lighting engineers, electrical wholesalers and contractors, architects, utility lighting specialists and users of commercial and industrial lighting from this country who will attend.

A Hundred Manufacturers to Exhibit—This Exposition, sponsored by the Industrial and Commercial Lighting Equipment Section of the National Electrical Manufacturers Association, brings together under a single roof, the latest products and designs of a hundred leading manufacturers of every type of lighting equipment and other allied products. In many cases, manufacturers will exhibit new pieces of lighting equipment for the first time, when they are shown in their booths at the Exposition.

New Plastic and Louvered Devices—The increasingly-favored new Plastic Developments will especially be given a large part in the displays—particularly the latest louvered panel and all-over-ceiling effects.

"Father of Planned Lighting" Gives Three "Whys"—Joseph S. Schuchert, Manager Commercial Sales, Duquesne Light Co., Pittsburgh, Pa. sends in these potent reasons for his attending



the Third International Lighting Exposition: "A long dissertation on the benefits of attendance can be boiled down to three major points:

"1. Knowledge — to be able to see what's new in equipment — what's new in ideas — what's new in plans both from a technical angle and a sales angle that might help to develop the tremendous possibilities of the lighting market.

"2. Inspiration — inspiration gained from the show itself and from the spirit of the exhibitors and the people attending — inspiration which means enthusiasm to work aggressively both as an individual and an industry to do the job which can be done.

"3. Contacts — contacts with the important people from all branches of the lighting industry — the manufacturers, the distributors, the contractors and the utilities — contacts which cement personal relationships and set the stage for expanded and more successful cooperative effort."

A Preview of Trends — Another benefit that will accrue from attending the Exposition and Conference is that the lighting engineer will get an excellent indication of the trends which are taking place in the field of lighting — trends of which he will want to take the fullest advantage in making his designs and plans.

First of all, there is a trend toward closer analysis of the specific use and lighting problems of the final user and the development of equipment, lamps and installation techniques which will solve these specific lighting problems. This trend was already noticeable at the last two expositions.

Trend to Better Use of Color — There is the trend toward a better understanding and more intelligent use of color in lighting and its proper application for the physiological as well as the psychological effect. This use of color is being closely related to the more effective use of light. Color and light are being coupled to produce the desired objectives. Color has always been a factor in store lighting but now is recognized as an important element in the lighting of school rooms, offices and industrial interiors. More attention is being paid to the right use of color on walls, on furniture, on desks and on machines.

Toward Better Design and Construction — There is also noticeable another trend toward better design and better construction of lighting equipment. This will give greater durability, better performance and easier maintenance of lighting units. This is especially noticeable among the manufacturers who are exhibitors at the Third International Lighting Exposition, because they are leaders and subscribe to high standards of lighting design.

Conferences Another Highlight — The Conference Sessions are another phase of the Exposition that will be of prime importance to the lighting engineer. These will be a highlight of the morning meetings each day of the Exposition.

Glimpse of Tentative Program — A tentative advance list of the events on the program has just been released by F. I. Wilson, Conference Program Chairman. Although not yet complete, it gives some idea of the significant material on this subject of Planned Lighting, that will be presented in papers by various authorities and then be subjected to round table discussion.

Demonstrations — In each day's conference program, the discussions will be followed by a dramatic demonstration on some important phase of lighting. On Tuesday, March 29th, the conference sessions will be officially opened at 10:00 A.M. by G. T. Morrow, Curtis Lighting, Inc., who is Chairman of the Exposition Operating Committee.

He will introduce as first speaker, B. W. Clark, Vice-President of Westinghouse Electric Corp., and president of N.E.M.A., speaking on the subject "Lighting and Its Place in the Electrical World Today."

Lighting Competition Merit Awards — Scheduled for 11:00 A.M., is the presentation of Merit Award Competition Winners by R. D. Bradley, Day-Brite Lighting Inc., Chairman of the Merit Award Competition Committee. At this session, the winners in the various classifications of the Merit Award Competition will be presented in person with the Merit Award and Gold Seal Cash prizes given to those who submit the most outstanding case studies in Planned Lighting.

Exposition Opens Noon Tuesday — Official opening of the Exposition is to take place Tuesday noon, with elaborate ceremonies. For the Wednesday morning program, the President of the National Electrical Wholesalers Association has been invited to act as Chairman.

Eric Johnston, Wednesday Speaker — The first speaker will be an internationally known representative of American Business, Eric Johnston, President, Motion Picture Association of America, and a former President of the United States Chamber of Commerce, who has recently spent considerable time in Europe, studying the International situation. His subject will be "Where Do Business and Lighting Go From Here?" The demonstration for this session will be on lighting of the future, a new and dramatic presentation, by the General Electric Co.'s Engineering Department, exemplifying the Exposition's theme, "Get New Light on Lighting." This will include colorful demonstrations of the latest lighting techniques.

For the special Wednesday evening session, Mr. Wilson's Committee has planned a very unusual program. The exhibitors will be hosts to the visitors and special events are being arranged that will mark this evening meeting

(*Continued on page 76*)

Recent Developments in Lighting Equipments and Application

Report of the I. E. S. Committee on Progress -- 1947-1948

S. G. HIBBEN, Chairman

DESPITE MATERIAL shortages during the early months of 1948 and the disturbances of world politics during the latter part of the year, the lighting arts and sciences have moved forward substantially. This report of the Committee on Progress attempts to summarize some characteristic features of that advance. When a several-billion-dollar industry is on the march, one will understand that many of the items contributing to a year's progress cannot be detailed. Such items as are mentioned should not be taken as necessarily superior to others unavoidably omitted, but those presented are selected rather to show trends and general characteristics. Advances in some of the many lighting fields, domestic and foreign, cannot even be listed, and a comprehensive bibliography would be exceedingly bulky. The material of this report, however, condensed as it must be, offers convincing evidence that on the whole, lighting (and the use of allied energies) is moving steadily onward.

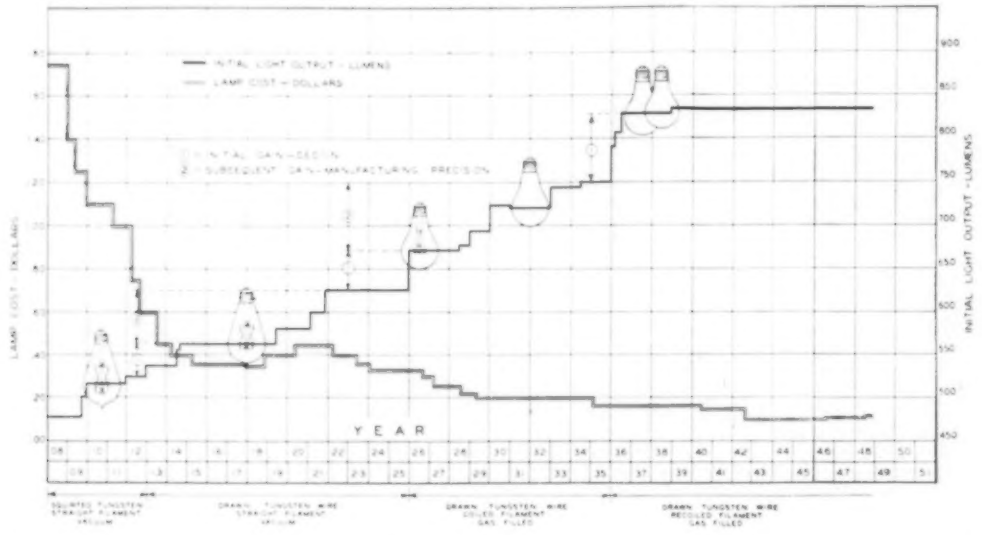
General Growth of the Market

In the United States the total lamp (bulb) market increased from a list value of some $152,733,000 in 1939 (a normal pre-war year) to $385,994,000 in 1947, the last available figure. This was an increase of 153 per cent over pre-war, and all indications point to a continued, though not quite so exuberant, increase during the current year. The estimated number of large lamp bulbs sold in the

A report presented at the National Technical Conference of the Illuminating Engineering Society, September 20-24, 1948, Boston, Mass.

Prepared by the Committee on Progress, 1947-1948. Chairman, S. G. Hibben; Vice-Chairman, Alston Rodgers; P. H. Anderson, A. C. Barr, E. W. Beggs, L. J. Battolph, O. P. Cleaver, Leroy C. Doane, Milton B. Hastings, I. L. Illing, Walter J. Jones, Arthur P. Larson, C. D. Miller, R. G. Sluser, J. Steiner, E. D. Tillson, A. S. Tyler, and S. B. Williams.

Figure 1.—Light output and cost. 1948 saw no consequential changes in filament lamp efficiencies and a very small increase in list prices. This graph refers to the standard 60-watt lamp, 120 volt range, U. S. manufactured.



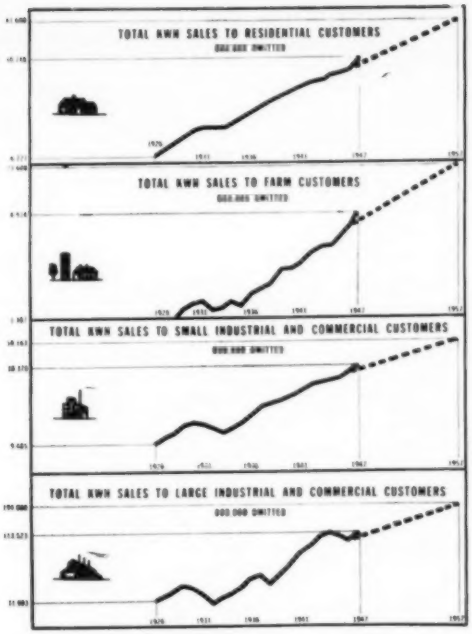

TOTAL KWH SALES TO RESIDENTIAL CUSTOMERS
TOTAL KWH SALES TO FARM CUSTOMERS
TOTAL KWH SALES TO SMALL INDUSTRIAL AND COMMERCIAL CUSTOMERS
TOTAL KWH SALES TO LARGE INDUSTRIAL AND COMMERCIAL CUSTOMERS

Figure 2.—The growth of power usage in the next ten years should be paralleled by lighting growth.

United States in 1948 is 880,000,000, or approximately six per cent over 1947.

From the pre-war year of 1939 to 1947, domestic *miniature lamp sales* at list grew from about $31,700,000 to $62,150,000. *Sealed beam automotive lamps* grew from $377,000 to $28,300,000. *Sales of Christmas tree lamps* increased from $9,950,000 to $22,559,000. Thus the gross values have nearly doubled in eight years.

Fluorescent lamps at list in the United States were $3,717,000 in 1939 and, in spite of substantial price decreases, were $75,445,000 in 1947. All *large incandescent* lamp sales in the same period increased from $103,240,000 to $184,370,000; *photo lamps* from $3,435,000 to $13,181,000. In nearly a decade of progress, the curve of the sales of large lamps parallels almost exactly the curve of the total kilowatt hour sale of electric power. Both, for 1948, will definitely exceed the records of 1947. Approaching one billion units, the per capita consumption in the United States is approximately six large lamp bulbs annually.

General increase in power consumption in the residential field (while not separating lighting from appliances) would indicate a growth in lighting power consumption roughly in proportion to the average annual kilowatt hour sales per home meter. These sales are as follows:

1927	450	kilowatt hours
1932	600	" "
1937	800	" "
1942	1022	" "
1947	1438	" "

It is estimated that the 1947 total of 40,748 million kwh in electrical energy sales to residential customers will double by 1957. These data are indices of growth in the usage of light.

Fluorescent Illuminants, 1948

The tenth anniversary of the fluorescent lamp in the United States was celebrated April 21, 1948. One large United States manufacturer estimates his production of 206,500,000 fluorescent lamps in that decade. The sales progress indicates that the domestic increase of 1948 over 1947 will be about 9 per cent. Estimates are that approximately 86,000,000 units were sold this year in the United States, compared to 79,000,000 in 1947.

Indicating further progress in the fluorescent field, announcement has been made of a 96-inch T-12 bulb instant-start slimline fluorescent lamp to supplement the former T-8 bulb. The modified lamp is rated at 5800 lumens—to be designated, at one current value, roughly as one watt or 60 lumens per inch. For a 12-hour start period it has a rated life of 6000 hours. The voltage is 700 starting and 175 operating, and among several currents, 400 and 600 milliamperes. A heavier loading of pre-heat lamps is promised.

For decorative lighting, a 40-watt fluorescent lamp has appeared with a spiral marking, giving an interesting color pattern by reason of the view through the clear lines into the arc stream. In still another special class, a photographic fluorescent

Figure 3.—High current short-arc mercury lamps developing in England and the U. S. promised projection sources of extreme brightness.

Figure 4.—Upper lamp shows the new 25-watt fluorescent tube compared in size with the 20-watt. New lamp is 33" T12.

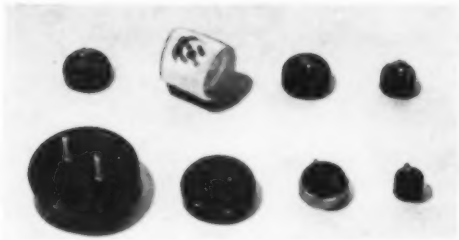


Figure 5.—The line of fluorescent lamp bases or end caps used in the U. S. in 1948.

lamp is offered with a phosphor rich in actinic rays and suitable for color films.

Announcement was made late in the year of a 25-watt 33-inch T-12 fluorescent lamp rated at about 1400 lumens (56 lumens per watt). With this more convenient length, together with a starting voltage of 115 and operating voltage of 53, this lamp seems to be destined for wide usage, especially in work areas in the home and possibly in vehicle lighting fields.

Progress wtih cold cathode fluorescent lamps has been generally towards standardizations of length and along lines of safety. Section 4202, Article 410 of the National Electrical Code calls for suitable devices in any series a-c system of high voltage to prevent contact of live lamp ends. A new disconnect fuse has been announced for this purpose. Hairpin shapes are mentioned, spreading 6 to 10 inches, with loops about 46 inches long. In this field also, modest trials of cold cathode tubes for street lighting are reported from abroad.

To provide a small night-light which may be burned continuously with long life, there has been made available the one-watt S-11 bulb white fluorescent glow lamp plugging into any baseboard or similar receptable. This lamp has been supplied with a parallel blade prong base and is rated at 10,000 hours' life. Average operating cost is on the order of 3 cents a month.

In the United States announcement was made of a warm white or "warm-tone" fluorescent lamp in all standard sizes. With a higher efficiency, on the order of 7 per cent increase over some of the other "whites," the lamp is designed to approximate closely the color of the large-wattage tungsten filament incandescent lamps. A new soft-white tint has been offered that may appear slightly less orchid than the original "soft-white" but yet will equally compliment the complexion. Slightly different tints are standard in Western Europe, as seen in the following table:

	American		British	
"Daylight"	X = .313	Y = .323	X = .355	Y = .360
Warm White	.436	.403	.435	.380
3500 White	.405	.390	——	——
4500 White	.360	.363	——	——

A closer control of color and a better sustained mantenance of luminous efficieney has been reported, through limited usage of improved phosphor coatings, known as halo-phosphate compounds.

Through the novel use of krypton gas filling and other improvements, the 85-watt T-17 bulb 60-inch fluorescent lamp can replace the former 100-watt rating in the same size and with an increase of some 15 per cent in usable efficieney. The gain here is in releasing watts for still more light, and in loading this lamp less heavily. One advantage of krypton is to lower the operating voltage.

Figure 6.—Showing studies in progress on the 1000-watt mercury lamps using Cadmium to add red lines to the spectrum. Another method is to employ a heat-resistant phosphor converting near ultra-violet radiations into the visible.

On long, slim lamps which formerly were aided in starting by the use of a thin metallic stripe running the length of the lamp, the same results have been accomplished in some cases by a silicone coating, an advantage in appearance and with no possibility of electric grounding.

The 20-watt fluorescent lamp has been marked specifically for both a-c and d-c power, performing well on both.

Metallic Vapor or Discharge Lamps

Progress has now determined fairly definitely that air-cooled mercury vapor lamps mid-way between very compact short sources and long tubular sources can be expected to give a luminous efficieney not far different from normal fluorescent lamps. However, the year's progress has been chiefly along paths of the short arc in a quartz tube,

in order to have a concentrated source suitable for prismatic lens or specular reflector control. The former T-14 jacket of the 250-watt mercury lamp was enlarged to T-18, and made in high transmission glass, while the T-16 jacket of the 400-watt lamp was enlarged to T-20. These improvements benefited life, maintenance and efficiency. For example, the new 400 watt E-H1 lamp is now rated at 21,000 lumens.

Several methods of correcting the color of high intensity mercury lamps are being experimentally tried. One being studied involves color-correcting phosphors on the outer bulb or within the enclosing glassware. Another development covers the addition of the metal cadmium which, in variable proportion, and at an efficiency slightly less than for pure mercury, will emit as much as some 70 per cent of the red content of daylight. These cadmium-mercury lamps are being investigated for color motion picture film photography, and were mentioned during the year in technicolor studio work.

Remarkable progress has been made, first in England and later in the United States, with super-high-wattage mercury lamps, where the current density of the metal seals is as much as 10,000 amperes per square centimeter. This has led to seals in glass or quartz carrying as much as 250 amperes, generally through foliations of molybdenum sealed in quartz. These large lamps (such as the 10-kw with a 10-mm diameter quartz bulb operating at 750° C) have an arc brightness intrinsically greater even than the surface of the sun. The calculated brightness uses the formula:

$$\text{Brightness (stilb)} = 3 \times \left(\frac{V}{L}\right)^{1.5} \times A^{0.7}$$

L = arc length, cm
V = volts
A = current, amperes

On the basis of observational measurement, the sun's surface brightness is 1.6×10^3 stilbs compared to some of these high-current mercury arcs of 3.1×10^3 stilbs. The reported efficiency is about 55 lumens per watt for a 6-mm arc—the importance of the development being a compact source for remote control that may supplement the carbon arc, particularly in studio lighting work. Color modification for studio use has proved promising.

A limited production continues in England of several sizes of medium-pressure mercury lamps using filament ballasts within the same bulb, on 50-cycle 230-volt range supply. This eliminates the ballasting transformer.

An interesting example of research progress is in the use of Xenon (gas) in flash tubes of 30, 20, and 10-cm lengths and employing 100 cycles per second for excitation. Large amounts of power are released at each flash, on the order of 300 joules. In connection with such flash lamps, studies have been reported on slow decay phosphors in order to carry over between flashes. A photographic flash tube of three-fourths of a billion peak lumens appeared, this chiefly to enable the photographer to duplicate indoors the appearance (including true color) of outdoor scenes.

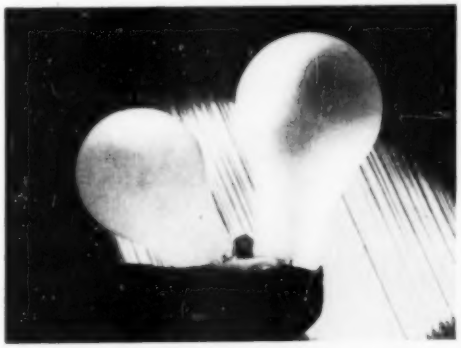


Figure 8.—Showing the new A-19 bulb 75-watt filament lamp compared to the A-21 bulb size.

Last year's report mentioned quick flashing krypton tubes which, in reflectors designed for airway approach lights, were rated at the surprising figure of 3,300,000,000 candlepower. Supplementing these units and of novel interest from the standpoint of contrasting color, are neon "blaze" tubes which by controllable operation as to flash time and discharge can (in reflectors) have various candlepowers in multiples of ten from 100 to 10,000,000 inclusive.

Figure 7.—Floodlighting automobile, dog and horse race tracks added to the many examples of outdoor sports lighting.

Ultraviolet and Germicidal Sources and Their Application

In a report to the I.C.I. Congress in Paris, the U.S. 1948 annual sales of germicidal lamps were

estimated at 575,000 units; by 1950, some 2,000,000 units. This year's estimated power for these lamps is above 20 million kwh.

A glass of high transmission in the region of 2537A (Vycor) has been developed for germicidal lamps, especially the recently announced 36-inch slimline model. This lamp can operate on the regular 42-inch slimline ballast or on 120, 200, 300 and 420 ma. The latter current rating has generally been reserved for installation in air ducts. This lamp is rated at 6000 hours at 12 hours per start. By a chemical variation in the glass, the lamp's output may generate either high or low ozone.

In addition to the reduction or killing of microorganisms or in addition to the abiotic principles of sterilization, investigations, notably in Sweden, give evidence of some related general health benefits from prolonged exposure to mild amounts of short-wave ultraviolet. Some of these same benefits have been studied in connection with poultry raising.

In the low-wattage germicidal field, and for applications such as in small storage cabinets, there was announced the 3.5-watt S-11 bulb 12-volt lamp with intermediate screw base which has an output of one tenth ultraviolet watt.

A notably new sunlamp—fluorescent—has been announced in the 20-watt 24-inch; and 40-watt, 48-inch sizes. Operating on the same accessories as the standard fluorescent lighting lamp in corresponding sizes, the respective ultraviolet outputs at approximately 2960 A wavelength are 50,000 and 120,000 E-Vitons, a surprisingly high efficiency.

Among new ultraviolet measuring instruments may be noted a suggested Tau Meter, to predict the erythemal time of, say, sunlight of variable intensity as protection to sun-bathers, and the Vitometer to measure the quantity of biologically effective ultraviolet energy.

The idea of large artificially-lighted Solaria was further popularized in 1948 through a number of demonstrations and by at least one permanent hotel installation. The large hotel Solaria, widely advertised, uses infrared units for human therapy and comfort, type RS sunlamps for varying degrees of 3000A-range ultraviolet, and combinations of filament, vapor, and fluorescent lamps to duplicate sunshine qualities, colors and intensities.

Paints were further perfected as to maximum and also minimum reflectances in the regions of 2500A and 3000A.

New interest in black light has evolved by reason of some exceptionally fine murals done with fluorescent pigments; by the additions of some phosphorescent novelties in the toy and small portable lamps field; by the use of black light to determine by fluorescent color the age and condition of

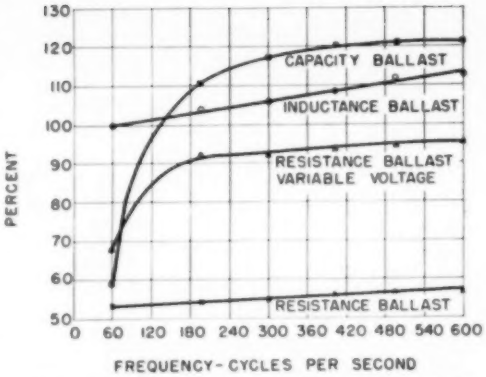


Figure 9.—Variation of overall luminous efficiency of the 40-watt fluorescent lamp as related to frequencies of alternating current supplied. During 1948 these studies applied to aircraft and vehicles in particular.

eggs; and by moderately priced phosphorescent coated papers.

In this latter class, the military need for a nighttime marking device was met by a new material consisting of phosphorescent tape overlaid with stripes of white paint impregnated with tiny glass spheres, for retro-reflection. The importance of this material in roadside signs and obstruction markers justifies a record of its properties:

Phosphorescence:

Elapsed time after activation	20 minutes	1 hour	2 hours	5 hours	10 hours
Brightness in microlamberts	2.0	0.48	0.25	0.05	0.03

Reflectivity:

Incident Angle	Divergence Angle	Reflection Factor
0 degrees	0.33 degrees	2.1
0 "	2.00 "	2.9
30 "	0.50 "	4.0
70 "	0.33 "	2.2
70 "	2.00 "	2.0

(Reflection factor is taken with brightness of white blotter as 1.0)

An increased application was seen in 1948 of the small portable battery hand-lantern emitting black light from a miniature bi-pin fluorescent lamp, first made available a few years ago, and in uses of portable ultraviolet sources in gem and mineral studies. Field inspectors now employ these devices widely for crime detection, and for tracing perpetrators of false fire-alarms.

Large and Miniature Filament Lamps and Accessories

Progress in stadium and sports floodlight has continued along lines of units producing less glare in the stands and more light on the field. One such unit is the narrow beam 20-inch parabolic projector with impact resistant glass lens. This accommodates standard 750- to 1500-watt general service

lamps, of the new 1750-watt, 37,400-lumen, PS52 bulb filament lamp which, provided with an internal condenser grid, has an improved lumen maintenance operating (300-hour life) on the regular normal socket voltage. One baseball park uses 1386 of the 1500-watt lamps operated 10 per cent above rated voltage, or a total of 2416-kw, and secures 200 footcandles on the infield.

An interesting use of the 6-volt reflector spot in the sealed PAR46 bulb is exemplified by a portable industrial floor lamp, each unit carrying twin projectors for a total of about 80 watts. At 6 feet the twin unit gives roughly a 5-inch diameter spot of at least 1500 footcandles and has been offered for welding and any services where a low heat, high powered narrow beam is needed. This illustrates the extension of certain low-volt, sealed-reflector lamps of superior beam control into the industrial field.

From England have come interesting examples of the 12-volt 300-watt or similar low-voltage projection lamps with filament coils uniformly touching adjacent coils throughout their length. By careful proportioning, there is no tendency to arc across and consequently a "solid" rectangular light source is produced, of minimum area.

Several useful automotive type sealed reflector bulb lamps formerly furnished in the 5¾-inch diameter PAR 46 bulb have been made available in the 4½-inch diameter PAR 36 bulb. In the standard 6-8 volt class, these include the 25-watt general utility spotlight; the 35-watt fog light in both amber and clear lenses, and the 30-watt shielded filament projector lamp. For trucks and marine service there has been made available the 5¾-inch PAR 46, 12-volt spotlight reflector bulb lamp. Other new lamps in this class are mentioned under the section on airways and airports.

In the line of standard colored filament lamps, progress has been made with the application of a ceramic or glazed coating applied to the lamp bulb. These ceramic colored lamps have recently been made generally available and are expected to replace former types of applied colors in some sizes. The R-20 bulb, neck-silvered lamp appeared in heat-resisting bowl colors of red, green, blue and yellow.

In order to achieve lower costs and more convenient fittings, less storage space, etc., the former 75-watt A-21 bulb filament lamp, 120-volt class, has recently been manufactured in the A-19 bulb, with coiled-coil filament.

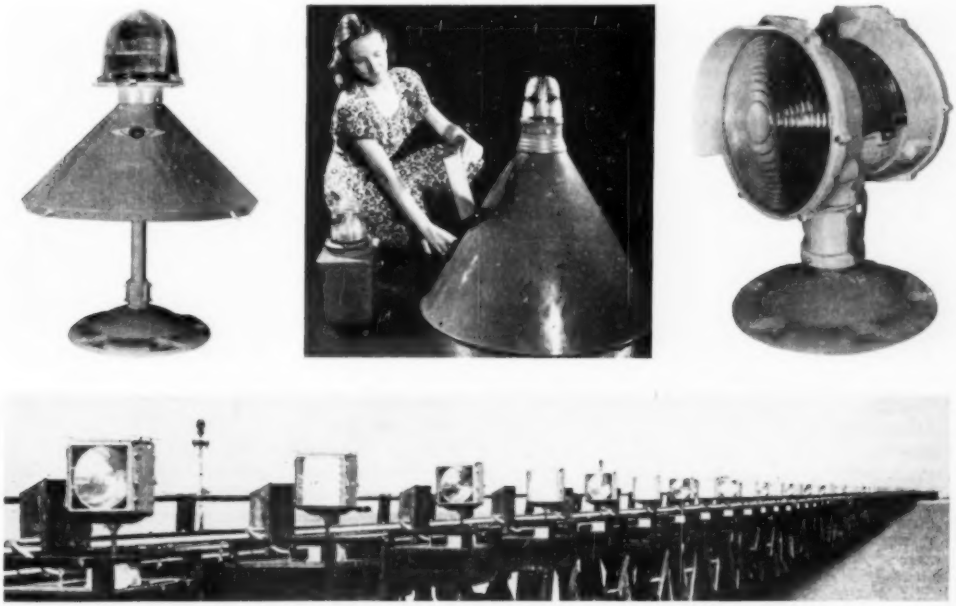


Figure 10.—Top left. Example of a new lightweight elevatel runway light of 2000 cp from a concentrated filament 30-watt lamp. Center. A portable battery-operated neon danger or obstruction marker for use at airports or on highways. Right. A bi-directional runway light for bad weather landings having 80,000 cp with a 200-watt concentrated filament source. Bottom. Alternate neon and krypton flashing approach lights as permanently installed at Idlewild Airport.

Figure 11.—Fluorescent lighting of Kingsway, London, showing the uniformity of pavement brightness.

The 75-watt spot and flood lamp in the R-30 bulb was announced as a "little brother" to the popular 150-watt R-40 bulb. In this latter size, the year saw advancement in application of inside white coated diffusing finish applied with a differential in density between neck and bowl, for use base-down in portables. The medium skirted or mechanically held base for such lamps in this bulb size that might operate hot, was offered. For reflector infrared lamps, there appeared a 500-watt rating in hard glass, medium base, and for spot and flood lighting a mogul base general lighting service bulb in 500 watts.

For louvered semi-indirect basins, or where the intensities directly downward need be emphasized, the semi-silvered or band-reflector PS bulb lamp in three wattages was made available.

A midget grain-of-wheat lamp appeared this past year—the tiniest yet made. Added to the 120-volt class was the R-12 neck silvered lamp, 25-watt, 50-hour life, for special localized and effect lighting.

Airways and Airports

Progress has been made throughout the world in lighting airports, but especially in the United States where a seven-year program has been embarked upon. This program includes the construction and lighting of 2900 small airports of which about 200 are scheduled for completion in 1948. International standardization of aircraft signals and markers was stimulated by the resumption of the I.C.I. Congress, where this subject was of major interest.

Interesting progress has been made with a bi-directional runway light, emitting some 80,000 candlepower with a special 200-watt filament lamp. It has roughly doubled the beam candlepower of former designs. This unit is intended to supplement instrument landings in heavy weather.

An improved runway light of 2400 candlepower using a recently developed 30-watt filament lamp represents a lightweight elevated unit with about double the efficiency of former types.

For the tops of typical runway marker units, there has been offered the modified PAR 64 sealed reflector lamp. This is unique in that it burns base down, has extra high beam candlepower, and operates at 300-watts on the regular 120-volt circuit. Correspondingly, a 95-watt 6.6-ampere 6AR46 concentrated filament lamp has been announced for CAA L-820 runway markers. A type DI unit lamp of 200 watts, 6.6 amperes, has also been added—this in a T-14 bulb with medium prefocus base.

An airplane taxiing lamp, PAR 46 bulb, of 150 watts, 28 volts, has extended the benefits of narrow beam control, and lowered air resistance.

Street Lighting

Leading manufacturers in the United States have established dimensional standards for luminaires to provide mechanical and optical interchangeability of equipment at the joint between the reflector and head. This simplifies stocking and maintenance problems for the user.

Industry standardization has settled upon a two-voltage rating for the street lighting service, namely 600 volts for multiple and 5000 volts for series rating (maximum). Likewise, series and multiple street lamps in corresponding sizes now have approximately equal mean lumens. Series sockets have been made interchangeable, and mechanical

improvements such as latch-on simplicity, stainless steel fittings, etc., have improved maintenance.

A fluorescent street lighting installation in Rugby, England, was recorded just two years ago, and several trial installations were illustrated last year. Now this source for street lighting is represented by more than 25 installations involving perhaps 900 fluorescent lamps. Most of these installations in England are using three-light fixtures of the 80-watt, five-foot size, although some are studied with the 40-watt, four-foot lamp. Trial installations exist also in Tel Aviv, Buenos Aires, Dublin, Nairobi, and elsewhere. Historically, the first permanent American fluorescent street lighting installation (Spartenberg, 1941), of 100-watt lamps, was lately extended considerably beyond the original 118 turn-lamp standards. Several months' recent experience in England suggests preferential spacing of 80 to 150 feet; a mounting height of at least 25 feet; the acceptability of 7000 lumens output per unit, or roughly 5000 output lumens per 100 running feet. After five months of normal service (without cleaning), records show a depreciation of the lamp alone of 19 per cent and of the complete unit (anodized aluminum reflectors enclosed in a clear plastic half cylinder) of 38 per cent. Total operating costs in London have been roughly $2000 per mile per year. Most of these installations operate on normal supply voltage of 240 plus or minus 6 per cent. With thermal starters, tests have shown starting as low as minus 20°C.

The 1000-lumen 6.6 ampere PAR 38 ribbed lamp was reported last year, with other street lighting filament lamp developments. This year mention has been made of an enclosing, diffusing test globe for this lamp, affording rough quick appraisal of the distribution pattern.

High intensity mercury street lighting continued to grow during the past year, especially with the E-H1, 400-watt lamp. Some three thousand units were added in North America. Moderate maintenance costs per useful lumen have been one proven advantage.

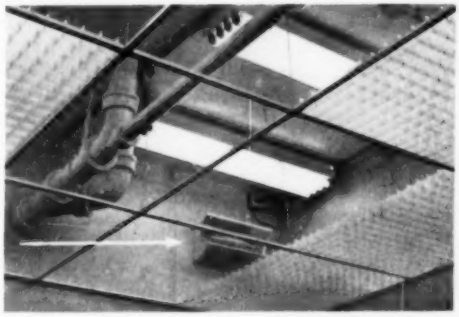


Figure 12.—As the usage of both metal and plastic louver-all ceilings expanded, the fluorescent lamps were joined by air-conditioning bactericidal units.

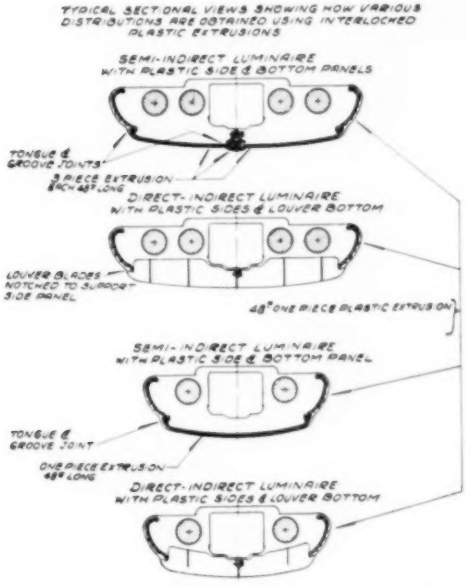

TYPICAL SECTIONAL VIEWS SHOWING HOW VARIOUS DISTRIBUTIONS ARE OBTAINED USING INTERLOCKED PLASTIC EXTRUSIONS
SEMI-INDIRECT LUMINAIRE WITH PLASTIC SIDE & BOTTOM PANELS
TONGUE & GROOVE JOINTS
3 PIECE EXTRUSION
DIRECT-INDIRECT LUMINAIRE WITH PLASTIC SIDES & LOUVER BOTTOM
LOUVER BLADES NOTCHED TO SUPPORT SIDE PANEL
48" ONE PIECE PLASTIC EXTRUSION
SEMI-INDIRECT LUMINAIRE WITH PLASTIC SIDE & BOTTOM PANEL
TONGUE & GROOVE JOINT
ONE PIECE EXTRUSION
DIRECT-INDIRECT LUMINAIRE WITH PLASTIC SIDES & LOUVER BOTTOM

Figure 13.—Showing the characteristic design of commercial fluorescent luminaires, flexible as to distribution of louvers and extruded plastic panels.

Lighting Education

Toward the end of 1947 the American *IES Lighting Handbook* was widely distributed. Now in the third printing, total sales to November, 1948, reached some 14,500 copies.

The Society's educational activities during 1948 reached an all-time high, in projects underway, planned for the future, and reaching completion. Outstanding committee projects completed include the long-awaited revision of the School Lighting Code, published in September as an American Standard Practice for School Lighting; the valuable "Lighting Practices for Stores and Other Merchandising Areas" published in June of 1948; and probably the most ambitious undertaking in the Society's history, the completion of plans for publication of a new journal, greatly enlarged in scope and format. Our progress report is published in the first issue of this new ILLUMINATING ENGINEERING.

In London, the Lighting Service Bureau, aided by the British I.E.S., designed and sponsored a remarkable lighting educational exhibit commemo-

rating 100 years of illuminants, termed "Darkness Into Daylight." In France there were issued commendable decorative poster advertising of light sources, and in other Western European and Latin American countries the progress in lighting arts was disseminated through numerous excellent journals.

The Chicago Lighting Institute announced its removal to 37 South Wabash Avenue, where it will continue the educational work for which it is famous.

After a seven-year wartime interruption, the International Commission on Illumination met in Paris in June of 1948, for a fruitful interchange of lighting knowledge between the 300 or more delegates from some 20 nations. Many important items of standardization were studied or agreed upon, and consequential papers on lighting developments and practices were presented. The Central Office was for the next term transferred to the U.S., the next Congress tentatively scheduled for Stockholm.

"Planned Lighting"—the country-wide movement sponsored by numerous business and promotional associations to encourage the thoughtful engineering approach in the design of any lighting installation, gained momentum and brought forth dramatic presentations, playlets and slogans. Such activities tend to give to the illuminating engineer greater responsibilities and a firmer professional standing.

Several pre-fab or parti-assembly construction companies, and notably a plate glass manufacturer, have told promotional stories of store-front modernization, emphasizing lighting for merchandising. Lamp manufacturers have operated several very impressive "road shows" which, on tour, have educated large groups of people in good lighting practice.

Several new books on light, lighting applications and related subjects were published during the past year, a partial list of which may be found in the subject-index of ILLUMINATING ENGINEERING for 1948, to be released soon. Among others, a new book on residential lighting, and one on infrared lamps and applications have had wide distribution in the U.S.

Trends in Materials and Equipment

Space does not permit detailing the progress in the vast field of luminaire design, but illustrative mention may be made of the following:

1. All-louver ceilings gained rapid acceptance, and indicated a popularity where minimized glare is especially desirable. A 45-degree shielding angle was well accepted. It is reported that more than 30 school classrooms now have louverall ceilings.

2. Down-lighting as from 150-watt projector and reflector lamps either inset into the ceiling or as part of the fluorescent luminaires to spot-light merchandise, grew apace in retail stores and hotels.

Figure 15.—A safety type of fluorescent luminaire used in a British mine, self-contained with a turbo-generator driven by compressed air.

3. Completely assembled sections of coves, or valance boxes were offered for fluorescent units over windows or alcoves. Extended plastic boxes or cylinders or ribbed plates are available to house slimline and regular fluorescent lamps. Simple cove designs were suggested for farm kitchens.

4. Encouraged by slimline and other long tubular lamps, the problem of designing large housings of reasonable weight and cost was partially solved through such methods as remotely mounting one large capacitor for a plurality of fluorescent lamps, or by edge-joining extruded sheet plastic in the tongue and groove fashion, thereby eliminating metal stiffening ribs. In the field of plastics of the acrylic or methyl-methacrylate types (trade names of Lucite, Plexiglas, Perspec, etc.) there have been good results from material of 1.49 refractive index, a two per cent

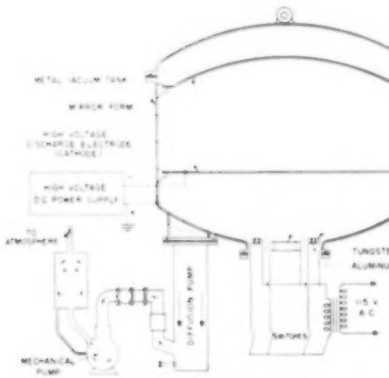


Figure 14.—Showing the method of depositing vaporized aluminum and a protective coat of silicon monoxide to secure a durable searchlight or projector mirror.

linear shrinkage, and good transmission between wavelengths 3000A to 23,000A. Four opals were suggested for standardization. In sheets one-eighth inch thick, these would respectively have transmissions of 80 per cent, 52 per cent, 26 per cent and 8 per cent. Corresponding reflectivities would be 16, 42, 66, and 84 per cent.

5. Large diffusing plastic sheets were hot-formed into RLM and similiar reflector shapes. In England there appeared an all-plastic one-piece industrial reflector trough for standard five-foot fluorescent lamps, at a cost very slightly above the metal unit.

6. The glassware art likewise progressed. Among many examples could be noted the uses as in schoolrooms of standard eight-inch wall blocks chosen with prismatic ribbing in accordance with the orientation of the room; the tempered and exceedingly tough formed glass for semi-indirect bowls and the availability of large sectional glass construction panels in metal frames. Surprise pink or similarly tinted sheet prismatic glass showed renewed interest for use in submarines, hospitals and places where relief from monotony is desirable. Pyrex glass tubes of 12-foot lengths were scheduled to enclose slimline fluorescent lamps in the lighting of tunnels.

7. For use primarily by the military forces, there was developed the new process of vaporized aluminum deposition upon a metal base such as a searchlight mirror, and protecting this specular surface with vaporized and deposited silicon monoxide. The invisible (quartz) coating

Figure 16.—Bus or tram lighting in England went forward with fluorescent lamps operating from direct-driven variable frequency generators.

resists heat and the elements. If a semi-transparent film of aluminum is deposited on silicon monoxide coated mirrors, there is achieved an interference filter that has low reflectivity in the visible spectrum but high reflectivity in the infrared. This electrolytic deposition is done in a vacuum chamber and the controllable resistant protective coating promises better reflectors for many services.

8. Shock resistant fluorescent luminaires were further improved for the U. S. Navy, and enclosed vapor-proof units with fluorescent lamps, explosive-proof, were added and serve, for example, in British coal mines. Incidentally, in such places where air-driven turbo-generators are used, an experimental installation uses 900 cyles at starting, and 400 for operating.

9. For desk tops and work areas constantly before the eyes, the U. S. Navy and others have standardized on a gray linoleum of approximately 30 per cent reflectivity. Roughly the same grade of finish is being extended for schoolroom desk-tops. Green or gray chalkboards replace blackboards, and the edge-lighted message board expands in variety to use black light (360 BL fluorescent lamps) and fluorescent chalk or crayon.

10. Machine tools are rather generally finished in recently standardized gray color, of specified gloss.

11. Considerable advance was made in plastic and perforated metal luminaires for use on headboards of beds, with small fluorescent lamps. Half circle fluorescent tubes were fitted to shaving mirrors and desk lamps.

Miscellaneous Progress

Water-cooling of the positive carbons of high intensity arcs has benefited these concentrated sources, for military searchlights, drive-in movies, and similar large projectors. The arc and its light output are more stable; the crater depth reduced some 15 per cent and the rate of electrode consumption reduced by 35 per cent. The crater brightness of arcs in practice seldom exceeds 1000 candles per square millimeter, but water-cooled arcs operating at upwards of 200 amperes exhibit at least 1500.

In the automotive headlamp studies, it appeared that while polaroid systems remain indefinitely in abeyance, nevertheless the need remains to increase candlepower in the clear road beam and decrease glare in the passing beam. At present, a pedestrian may not always be safely visible to the driver at upwards of 40 miles per hour.

A complete color examination skylight, using adjustable combinations of several illuminants, now

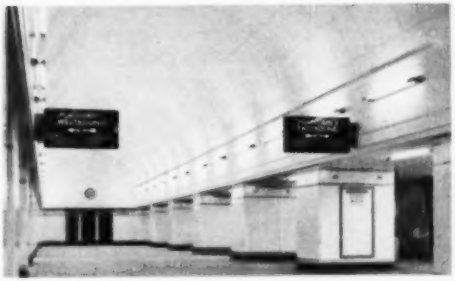


Figure 17.—Good examples of fluorescent lighting appeared in the illuminating of underground railway stations in England.

enables the user to select whatever particular "daylight" he wishes. Related to this is the progress in quality lighting for color engraving and lithography, but using colored fluorescent lamps with filters to illuminate the original, instead of color filters on the camera.

One example of extraordinary operating circuits for fluorescent lamps was the use of slimline lamps on a direct driven generator of a motor bus with variable frequency of 80 to 500 cycles, but with constant light output. Another was the operation of slimline lamps in subway cars on 200 milliamperes, using 600-volt d-c to 360-volt, 60-cycle, three-phase rotary converter. A third novel method was, for railroad trains, the use of an ampledyne controlled unit delivering substantially constant voltage and a variable frequency.

For viewing photographic color transparencies, or special advertising transparencies, there was available this year a fluorescent photocolor lamp with a high content of deep red in its light output.

During recent months the infrared lamps have found versatile uses. One mammoth oven does the complete job of both prime and finished coats on complete automobile bodies. Another portable small oven softens glued surfaces such as linoleum for removal from the floor. Others cement brake linings on brake bands or cook short-order meals in cellophane bags in restaurants. One justification of the illuminating engineer's interest in infrared radiations is the disposal of unwanted heat that usually accompanies high intensity lighting installations.

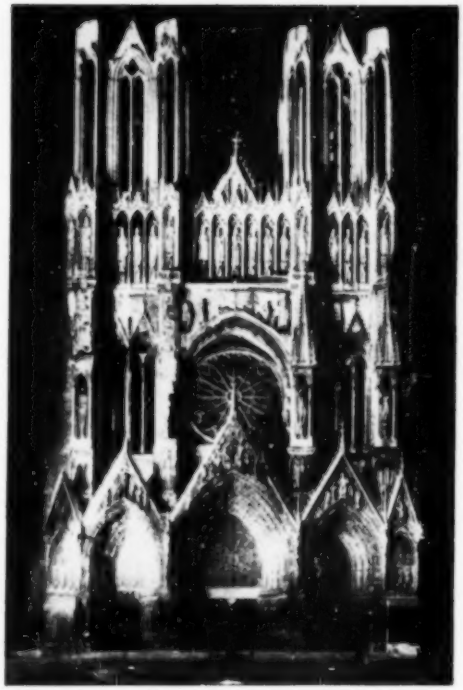


Figure 18. — Among examples of night-time beauty in floodlighting, the Cathedral of Reims in France is outstanding.

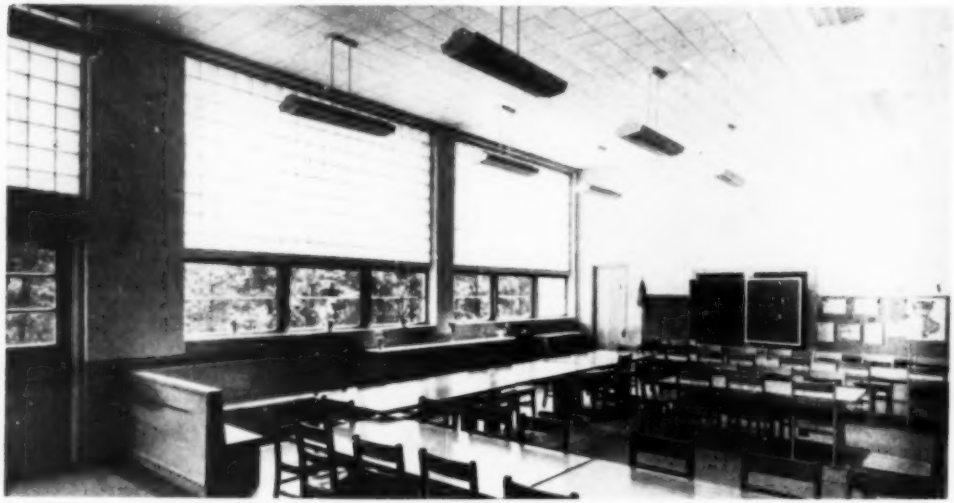


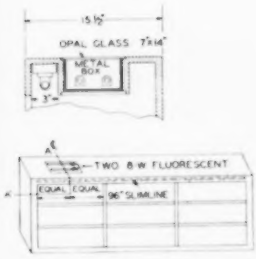
Figure 19.—Showing a progressive development of daylight control in schoolroom lighting using prismatic directional glass block construction.

Lighting a Combination Living-Dining Room

THE LIGHTING OBJECTIVE: (1) To develop pleasing background illumination for formal entertaining, (2) to accent books and figurines in the bookcase partition, (3) to highlight the centerpiece on the dining room table, and (4) to provide adequate light in some areas of the living room for occasional reading.

View of Dining Room End

Installation at West Hartford, Connecticut



Detail of Bookcase Lighting

General Information: The room is 34′ x 13′2″ with a 7′4″ ceiling. A low bookcase segregates the dining area, but at the same time offers a single large room for entertaining. The color scheme is developed from the "chaise and carriage" wallpaper on the two end walls — French grey background with soft red and black accents. Other walls have plain French grey paper, and the floor is carpeted in light pearl grey. The bookcase, woodwork, and ceiling are white. Cherry-red damask draperies are used over sheer nylon glass curtains at the two picture windows and the bay window. Furniture is mahogany of traditional design.

Installation: (1) A cornice is used on the three exterior walls of the room. Soft-white, 30-watt, fluorescent tubes are concealed in the cornice — two over the bay window, nine over and between the two picture windows, and three over a portion of the end wall in the dining room. These furnish a soft downward glow which accents the walls and drapery, and reflects light into the room. The sections of cornice not installed with lamps are closed. Wiremold channel No. 3000 is used for this installation and all ballasts are located in the basement.

Footcandle readings were taken on the dining room table with cornice lighting only, and showed 4.5 footcandles at the center, an average of 4.6 footcandles half way outward from center, and an average of 5.1 footcandles at the corners. Wall brightness readings in the living room were as follows:

Plain grey papered wall:		
Immediately under cornice	225.	Ft-L
Halfway between cornice and chair rail	4.	"
Immediately above chair rail	.75	"
White glass curtains:		
Immediately under cornice	250.	"

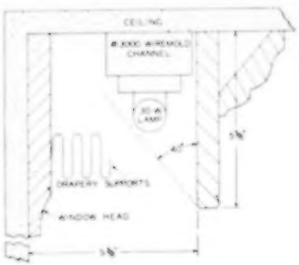
(2) The lighted bookcase segregating the dining area creates a "curtain of light" visible from the living room. A 96-inch slimline tube is concealed in the upper frame at the front of the bookcase, and directs light downward over the book shelves. In addition, a 6¼" x 13" x 3½" recessed metal

(over)

A.I.A. File No. 31 / 12

View of Bay Window End of Living Room

Close up of Dining Room Table



Section through Cornice

Section through "Project-O-Lite"

box is centered over the extreme left section. In this box is an installation of two 8-watt fluorescent tubes, side by side. The box is covered with an opal glass plate, flush with the top of the bookcase. This provides upward illumination for the low oblong crystal bowl of growing foliage placed directly over the opal glass insertion.

(3) The centerpiece on the dining room table is highlighted by means of a "Project-O-Lite" pinhole spot with adjustable shutter for extending the diameter of the beam to cover the entire table. The unit is recessed in the ceiling above the table and accommodates a 100-watt, 20 volt lamp with transformer.

(4) In view of the fact that a study across the hall is lighted for prolonged periods of reading or desk work, only a few areas in the living room are lighted for casual reading. The decorative lamps with plume motif used on the end tables, each accommodate two 60-watt incandescent lamps. In addition, the floor lamp near one of the fan-back chairs at the end of the room, is a C.L.M. (Certified) lamp equipped with a 100-200-300 watt incandescent lamp. A pair of traditional hurricane lamps on the buffet in the dining room are for decorative purposes only.

Equipment: (1) No. 3000 wiring channel (in custom-built cornice), Wiremold Company, Hartford, Conn.; (2) custom-built bookcase lighting units by Kent Metal Manufacturing Co., Brooklyn, N. Y.; (3) Project-O-Lite No. 1663, Century Lighting, Inc., 419 West 55th St., New York 19, N. Y.; (4) table lamps No. 2024, Borghese, 1231 23rd St., Washington 7, D. C.; floor lamp base No. M0615, shade No. SM6618, Mutual Sunset Lamp Co., 540 Empire State Bldg., New York, N. Y.

Lighting data submitted by Miss Myrtle Fahsbender, Director of Residential Lighting, Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J., as one solution of this home lighting problem, and to suggest ideas which may be used in solving similar problems.

Architect: Royal Barry Wills, Boston, Mass.
Decorator: Cion's of Farmington, Inc., West Hartford, Conn.

Published by the Committee on Publications of the Illuminating Engineering Society
51 Madison Ave., New York 10, N. Y.

Series XIV 1-49

Is Lighting Application A Lighting Problem?

By J. S. HAMEL

If the title of this paper is confusing, it is in tune with the subject to be discussed. This can scarcely be called a technical paper yet it deals with one of the problems in lighting that is close to everyone who has an interest in illuminating engineering, including architects, engineers, and manufacturers of lighting equipment.

LIGHTING application directly affects the big three in engineering; namely, the engineer or architect, the manufacturer, and last but not least, the client or customer. What does this business of lighting application mean to you as an architect or an engineer? Do you pick up a catalog, or two, and select the equipment you think will do the job? Or do you read some recent publication on what John Doe did at Podunk, and try something similar with a "new look"? Do you call in the representative of Illuminated Combine, Inc., and have them send their sales engineer over to give you the "dope"? Or are you swamped by a dozen or more enterprising lighting sales engineers who want to tell you how to do it? It is realized that we are excluding in the foregoing the architect or engineer who works out his own problems, with the assistance of capable technical help, and who approaches the lighting application phase as he would do for other phases of design and application.

Interpretation of Lighting Application

Just exactly why is this business of Lighting Application treated so differently from other engineering applications? To illustrate a point that seems to be a comparable condition, let us look for a little while at the present day approach to the problem of heating. We can choose heating—and might have chosen any number of other applications—because it deals with many of the same conditions with which we are concerned in illumination. We are concerned with environment, human comfort, physiological conditions, aesthetic considerations, and technical problems, not much unlike illumination. Yet, let us see for a moment how we approach a heating problem.

We first determine the character of the building to be heated, its location, its materials of construction; its exposures; and then on the basis of the interior conditions to be maintained we proceed to calculate the heat losses. We next break it down into the spaces or units and arrive at a total heat loss by commonly accepted and well-known methods of calculations. Here we have a set of figures, and it might be added that in this process we were perhaps concerned with special conditions in certain spaces requiring more than routine study. We had a few conferences with the architect or designer. At this point we still do not have a heating system, but we do have a sound basis for creating one.

We now reach what may be called the application stage—and the experienced engineer or architect knows what to do. He makes a decision on the basis of comfort, economics and clients' desires as to whether the system shall be hot water or steam, and as to whether it is to be radiant heat, direct radiation, indirect radiation or combinations of them. Then, on the basis of the decision made on the type of system, he starts placing radiators, selects equipment, boilers, type of fuel to be used, and translates this all into a layout on plans, with sizes shown, and the developed details to explain the scope of the work to be performed. To do this, he has at his disposal catalogs with accepted manufacturers' ratings. He may also call on a representative of a manufacturer for help in selecting the proper equipment. In the more special portions of the structure he will work with the architect and perhaps devise some new way to heat a space, "without radiators or piping," where the architect desires such a treatment.

Specifications are then drawn up, wherein the scope of the work to be done is specifically outlined and the various classes of materials described along with the workmanship required. The plans and specifications are then bid upon and ultimately a contract is awarded. In the case of well-written specifications and well-drawn

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Boston, Mass., September 20-24, 1948.

J. S. HAMEL is a Consulting Engineer, New York, N. Y.

plans the contractor can bid on and know the scope of the work, and he usually has certain latitude in the use of equipment. The "little guy" we talked about before, the client, gets a break too—he gets a low competitive bid and as a result may be able to save a few dollars. The parallel in the foregoing is clear as it relates to lighting. Why should not lighting be a straightforward engineering application, of sound principles and practical down to earth "no hokum" thinking? Let us next look into the typical approach to a lighting problem.

A Present Day Approach to Lighting Application

We start out to calculate the lumens required, on the basis of some predetermined design condition, and in this we are concerned with the materials of construction, exposures, use, daylight; we are interested in the decorative scheme, and often are able to work with the architect or designer to create some special effects, and do our best to coordinate the lighting with the architectural design and keep it a part of it. Of course we do not want to overlook the fact that in many cases there is very little calculation to do—we have many complete and effective tables which, with a little experience, will solve most of the engineering aspects of the lighting problem at hand. On the other hand, we do not want to gloss over the job of doing a lighting design—there are many factors that must be considered—quantity, quality, contrast, glare, and these must all be given due consideration. Yet when the foregoing is completed and the ideas of what is desired are settled, we are still far from finishing the plans for the work. We now reach the stage of lighting application, and here let us see how lighting will vary with the more accepted way of doing this phase of the design problem.

The lighting application part of this problem *could* be met with the same approach as that of the problem in heating mentioned in a preceding paragraph. But is it? If we could look in on an average case we would find more of the following procedure taking place. In one case which we all know too well, the type and sometimes the exact fixture to be used is determined before the lighting plans, if any, have been formulated. The client may have been influenced by ads he read, or by the pressure of some dealer in lighting equipment in the early phases of design, or perhaps the architect is partial to a type of fixture that he previously used. Some engineers—referring to engineers in general and not specifically to illuminating engineers—are prone to let matters take their natural course and lay out outlets in a routine manner and the architect will take the initiative in determining the type and style of fixture to be used. It does not seem that the procedure should be so much different from the case of the heating problem. Of course the style of fixture selected and placement of same should be a combination of the efforts of the architect and the engineer. There should be the same effort used in determining the characteristics of the fixture or appliance, insofar as its ability to produce the required conditions of illumination and further the more practical aspects of glare, efficiency, brightness, economics and maintenance, as is used in selecting heating equipment.

Somehow, in spite of the sound fundamental thinking that is done and can be done in regard to lighting application, there is a well-known tendency to make lighting a special art, apart from the other phases of engineering design. Of course it is admitted that there is a certain amount of romance, shall we say, or glamour attached to illumination. And further, in lighting-application, there is a need for a combination of engineering and artistic skills as may not be required in some of the other branches of engineering work, but even that is sometimes open to question. What phase of engineering work is so besieged with specialists as in lighting? We have a variety of specialists who operate in various ways—some as engineers, some as artists, some as decorators, and even manufacturers who will all solve your lighting problems. We should add here that many of them will do an excellent job; but why should lighting be treated so differently from the other branches of engineering? There are some theories to advance in outline form on this subject, and if they are not the complete answer it is believed they do act as contributing factors.

1. There are still a lot of "old wives tales" on lighting which strangely enough find wide acceptance. Have you ever heard, for example, of how some expert will expound fluorescent lighting as being the only way to cure all lighting deficiencies and cut your costs in half? Or of the one who says that fluorescent lighting is hard on the eyes and should be avoided, and that it costs twice as much as incandescent lighting?

2. There is a lack of acceptable and reliable data on lighting fixtures and appliances, such as may be found, for example, in the field of heating equipment. It might be added that there are excellent data but which are not widely used due to general lack of knowledge of their application.

3. There seems to be a tendency for those who practice the art, or profession, of illuminating engineering, to specialize too much. The illuminating work is separated so widely from the electrical phase of engineering, that in many cases there are both an electrical engineer and an illuminating engineer on the job. This may be necessary under certain conditions, but is not at all warranted in

most cases. We do not go out and call in a specialist to select the type and size of radiators to be used, because the mechanical engineer does the complete job. Yet many an architect and engineer will call in a specialist or two to select the kind and type of lighting fixtures to be used. And many times this happens even after the job is bid, and there is not time left to give much thought to selection of, or the time it takes to make these fixtures. It is believed that many manufacturers will bear out that statement.

4. There is a tendency on the part of the manufacturer to advance rather far into the engineering phase of lighting application. This practice has developed partly because of the inability, or lack of information, of the architect or engineer. Many manufacturers and distributors of lighting equipment today provide very complete engineering services for illumination, offered gratis to architects and engineers alike. Many architects and engineers rely heavily on this type of service, because they have no other way to solve their problems except via this service. This definitely tends, however, to keep lighting in the specialists' field. It also tends to raise the cost of lighting to the consumer. We see many jobs where no less than three different manufacturers have spent many hours and dollars in engineering time to assist in layout of a lighting scheme, only to find someone who never saw the job get the contract for the equipment. Now who pays for all this time and service—rendered free in the first place?

The four points brought out in the foregoing paragraphs serve to illustrate the reasons why lighting is so specialized and so highly exploited under certain circumstances. Now it is logical to ask, "What are you proposing to do about it?"

a. *First*, we must educate our engineers in training in the fundamentals and art of illumination. It is believed that more emphasis should be placed on the importance of lighting, and the need for an engineer who expects to work in architectural, or for that matter any kind of building construction, to understand lighting along with other electrical engineering work.

b. *Second*, engineers and architects should look at illumination in a more practical manner. The architect should expect and demand of his engineer doing the electrical engineering phases of the work, the equivalent service that he gets from the mechanical engineer on the heating or air conditioning. Should the architect hire an electrical engineer and then go out and hire an illuminating engineer? This may be warranted under exceptional circumstances, yet, little reason is seen why the lighting should be divorced from the engineering job as a whole. Many offices of architectural and engineering firms have already passed the stage of separating this work, but by far the majority still exclude lighting from the general planning and design. In fact, lighting many times comes up as the last thought, and after the job is under construction the electrical contractor arranges to buy the lighting equipment, after the outlets are installed, and usually after most of the money is spent, with the inevitable result of poor illumination.

c. *Third*, the industry must ultimately pull out of the engineering phase of lighting application insofar as furnishing free design and layout service to the architect and engineer. There is not a manufacturer or dealer who would not gladly do this if he could see his way clear, and if it became a general custom. As long as it continues, the cost of it must certainly be carried by the client who ultimately purchases the fixture. What would be the status of the heating appliance industry today if the various manufacturers did the design and layout of heating systems as a part of their engineering sales service? Engineering assistance can and should be given, and is accepted in general by engineers and architects alike in the application of equipment for a given job. The client pays once for this service when he pays the architect or engineer his fee, let us say as a percentage of the construction cost, which includes the cost of the lighting fixtures. Why should he have to pay it again indirectly as a part of the cost of fixtures?

d. *Fourth*, there must be a greater standardization of the type of catalog data and information furnished to engineers and architects. Many manufacturers and distributors are to be commended on the way they are improving their data for lighting application. That is rightly a part of their catalog information. This information must more and more be disseminated in a form that an architect or an engineer with average training can understand and can apply to the lighting problem at hand. It seems that some manufacturers like to have pretty pictures with eye appeal, but lack data that is useful in the practical aspects of lighting application. There could and should be a greater uniformity in the type of data and ratings supplied for fixtures and equipment. For the engineer to assume a responsible role in the field of illumination, the manufacturer must cooperate. Ratings on equipment and fixtures must be factual and must not be colored by lurid statements of performance. Many manufacturers have stayed with "facts and figures," but many of the colorful data sheets on fixtures or equipment are largely a mixture of fantastic claims and pictures.

These four suggested ideas on improving the lot of the engineer or architect engaged in this business of lighting application are certainly not the entire answer to this question. Should we continue to set lighting up on a pedestal by itself and divorce it from the engineering problems of a job insofar as design and application are concerned? Or, in the modern structure as planned and designed today, where lighting is so closely related to the other crafts or trades both in design and application, should not lighting application be integrated into the engineering of the project from start to finish, and considered as a part of the job, and not as a separate entity?

Conclusion

Perhaps what has been said so far might have been said in fewer words, or perhaps not said at all. A conclusion is a very important part of a paper, because sometimes it is the only part of the paper that is read. The title of this paper suggests that we change the question presented to a statement—Lighting Application is a Lighting Problem—because:

1. It is directly connected with the dollars the client pays for the lighting he receives. How it is done is a matter that affects every architect, engineer, and manufacturer. It means prestige to the professional man and means sales to the manufacturer, both of which are necessary to the welfare of each.

2. There are certain things wrong with the present approach to lighting application as it affects the engineering of a job as a whole, and the present tendency to set lighting application up in a class by itself, either to be done by a specialist, or by a manufacturer's representative who does the job "for free," must change to a sounder and more down to earth basis of approach. We must have the confidence of the client so that when he buys the services of the architect or the engineer he will be entitled to and will receive the best in lighting along with the best in heating and other trades. The manufacturer must not be burdened with the indirect costs of providing engineering service, actually at times in competition with the engineer who is supposed to be designing the job.

3. The job of lighting application must eventually be done in the office of the consulting engineer or the architect, and these professional men should see to it that their respective offices are capable of and are equipped to handle the illumination work as it comes up. The "specialist" will always be needed at times, but there is no reason why lighting should not be as much a part of the job as heating is. The client will and should feel that when he is buying the services of the architect or the engineer, he is getting complete service including the best in lighting.

There is no question that we are making some progress in the field of lighting application as treated in this paper. However, too few architects and engineers in general take active part in a society such as the I. E. S. Through this organization much can be done to bring more engineers and architects to think of lighting as a part of the job to be done, and less as a separate, nebulous subject to be talked about only by the Experts, and manufacturers of lighting equipment.

DISCUSSION

DAN DUNNE[1]: Mr. Hamel is to be congratulated for bringing to the attention of the Society the subject "Is Lighting Application a Lighting Problem?" Here is a subject on which we could well hold a forum discussion, asking for the views of the architect, consumer, electrical engineer and equipment manufacturer.

I would like to touch briefly on the three conclusions set forth in Mr. Hamel's paper:

1. Lighting Application is a lighting problem because "it is directly connected with the dollars the client pays for the lighting he receives." The difficulty here is that the manufacturer knows from sad experience the lighting is frequently paid for with the "last dollars" the client pays. Lighting equipment is frequently the final equipment purchased and installed. By the time the client is ready to purchase lighting equipment he is frequently at the point where there is little money left and the equipment finally selected on the basis of "what equipment will do the job the cheapest" rather than "what equipment will do the best job."

[1]Lighting Products, Inc., Highland Park, Illinois

2. On the second point in the conclusion I feel sure many manufacturers would be glad to "duck" the indirect costs of providing engineering service. The difficulty here is that in a good many cases the architect looks to the competent lighting representative for advice on lighting problems. Frequently architects do not have large enough offices to include electrical engineers, yet they feel with the help of good lighting sales representatives a sound job of lighting equipment selection and application can be done for the client. Here is a case where the lighting representative knows if he won't provide the necessary engineering service, his competitor will, and with it will probably go the final order for purchase of lighting equipment.

3. The third point in the conclusion is well stated, "the job of lighting application must eventually be done in the office of the consulting engineer or architect." As a manufacturer of equipment I would certainly go along with that. However, it would be wise to emphasize that the man in the consulting engineer's or architect's office responsible for the lighting should keep an open mind on the various lighting equipments on the market. As a former lighting representative for a manufacturer, I can remember many instances of calls on architects and consulting engineers when I was told that only a certain competitive manufacturer's equipment was used and unless I had something "just like it" there was no use discussing the matter further. All I was asking for was a chance to show the features of the equipment I had to offer, yet it appeared with the consulting engineer, "set" on a certain type of equipment, that I was definitely "out" as far as any consideration was concerned.

One point not covered in the conclusion is the availability to the architect of the competent utility lighting application engineer. Here is a case where the consulting engineer can call on a good lighting application man and still be free from the "bias" of calling in any one manufacturer's representative. The utility lighting engineer is frequently in a position of suggesting a certain type of lighting equipment for the proposed installation, leaving the consulting engineer and architect the freedom of selecting from several manufacturers the particular "type" of equipment recommended for the installation.

Floodlighting of New England Life Insurance tower, Boston, Mass., accomplished with 47 250-watt mercury-vapor units. Architect: Cram & Ferguson. Engineers and contractors: Hixon Electric Company. Photo courtesy Boston Edison Company through Electric Institute of Boston, Inc.

Light Sources and Colored Objects

By RALPH M. EVANS

THE SYSTEMS THAT are used to describe colors are all based on properties of the eye expressed in terms of the light which enters it. These systems, such as the Munsell, the Ostwald, or the ICI, arrange the colors systematically according to some definite scheme which is different for each system, but they all have one property in common. All of them are so arranged that if two colored objects are seen to match, they receive the same designation and no colors represented by different specifications can appear to match. The description, however, is in all cases in terms of what is actually seen or would actually be seen by a standard observer and never directly in terms of the light leaving the sample. This apparent anomaly is due wholly to the properties of the eye and calls for careful thought if it is to be understood and appreciated.

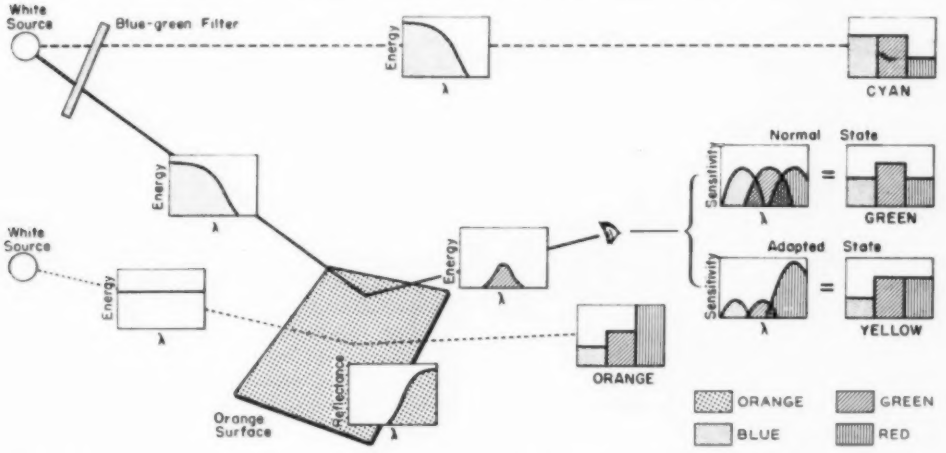
Presented as an illustrated lecture to the Boston Section, I.E.S. on December 6, 1946 and elsewhere.

MR. EVANS is with the Head of the Color Control Dept., Eastman Kodak Company, Rochester, New York. Member of I.E.S. Committee on Color in Illumination and Chairman, Subcommittee on Fundamental Aspects of Psychology of Color.

Describing the effect of different light sources on colored objects, and the physical principles involved.

There are many phenomena in color which cannot be explained without assuming a knowledge of the energy distribution with wavelength of the light which falls on a surface, and the present subject falls directly in this class. White light may be thought of as made up of a mixture of lights which differ in the frequency at which they vibrate in their passage through space. By passing such light through an appropriate optical device such as a prism or a grating, these different kinds of light may be spread out into what is known as a spectrum. Such a spectrum is usually continuous; that is, there is light present continuously from one end of it to the other. The wavelength changes continuously from the shortest visible light to the longest visible, starting as blue and passing through cyan (or blue-green), green, yellow, and orange to red with increasing wavelength.

Figure 1. The visual appearance of objects is controlled by the light source, the transmittances and reflectances of the objects, and the adaptation of the eye. Light passing through a colored filter is changed in energy distribution. When this light is reflected from a colored surface, it is changed again. The eye seeing this light will judge it differently if it is also exposed to the colored light from the source or only to the original white light. Here white light passes through a blue-green filter and reflects from an orange surface. It is seen as green if the eye is exposed to white light and as yellow if the eye is also adapted to the blue-green light.



When light falls on the usual colored object the only thing that happens to it, aside from changes in direction, is a change in the amount of light which is found at the various wavelengths in its spectrum after the light leaves the object. In other words, except for fluorescent objects which we shall not consider, when light strikes a colored object there is simply a change in the amount of light of some wavelengths to a greater extent than others. The light at each wavelength can be considered as acting independently of all others. A red object does not change all the wavelengths to red; it simply absorbs more at wavelengths which do not appear red.

Such a change can be described very easily by means of spectral energy distribution curves which show directly the amount of light at each wavelength in the light which is involved.

Sources with Blackbody Continuous Spectra

Suppose that light which has the same amount of energy at every wavelength is passed through a transparent red substance. All wavelengths except the longest are absorbed by the substance and only the longest wavelengths get through. By obvious analogy with a chemical filter, such colored substances are sometimes called light filters and the action may be thought of as one of filtering out the wavelengths which are absorbed. If we pass the light through two such filters, it is obvious that the only light which can get through *both* is that which is not absorbed by either. This concept is basic to all processes of subtractive color photography and is undoubtedly familiar. Where two dye images overlap, the light must pass through both before it is seen and the light which is visible is that which is not absorbed by either.

This type of action by colored objects is entirely general. Almost all colored objects in daily life show color because they characteristically absorb some wavelengths more than they do others. Objects are most generally seen under daylight or tungsten filament artificial lights. Their colors stay about the same, so they are spoken of as being *that* color, forgetting, or never realizing, that if a different light source were used they might be quite a different color. It is this phase of color which is the subject of the present article.

Exactly the same principles are involved in reflecting objects as in transparent filters. We can, in fact, generalize rather completely. The final energy distribution is determined by the relative amounts of light of various wavelengths that are removed from the light by each object in its path. It is entirely independent of the nature of the objects, provided they do not themselves remit part of the light at a different wavelength. Such fluorescent objects or filters depend for their effect not only on their absorption but also on the nature of the light which strikes them. For ordinary objects the series light source to colored filter to colored object to eye, is the same as light source to colored object to colored filter to eye. If the absorptions are the same, the series light source to colored object to eye is also the same.

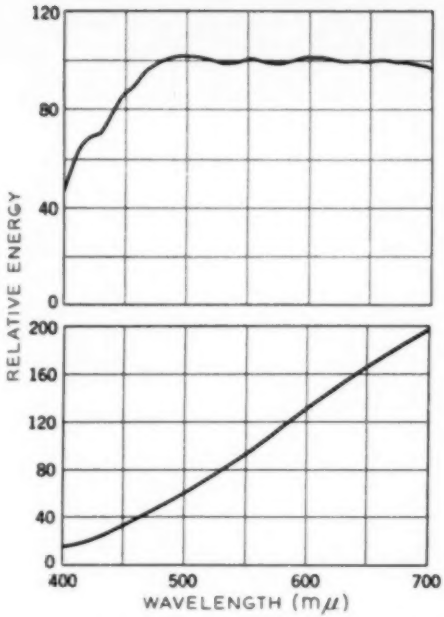


Figure 2. Spectral distribution of one kind of sunlight (top) and of a typical incandescent lamp (bottom).

The exact equivalence of these cases for nonfluorescent colors is important to understand because the color seen in any combination will depend not on the color of the objects as seen visually in daylight, but on the energy distribution of the light which is left over after absorption by the objects.

When light is absorbed selectively, it does not matter in what order the absorptions occur, and a light source with no filter over it or a light source and filter combination act just the same. It is the actual energy distribution of the light at each step that counts and not the way in which this distribution has been produced. In every case the energy distribution of the final light which reaches the observer's eye is the remainder after all the absorptions.

It follows from this, of course, that in order for

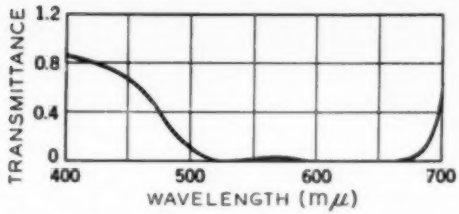


Figure 3. Spectral transmittance distribution of a purple signal-glass.

light to be present in quantity at any wavelength it has to be present in the initial light from the source and not be strongly absorbed by any of the objects.

Sources Discontinuous or Superposed Banded Spectra

In all the light sources which were common until recent years there was light present at all wavelengths, the main difference being the relative amounts of energy at the different wavelengths. With such light sources it is possible to have residual energy distributions with almost any relative distribution. At the present time, however, there are a number of common sources which are quite different. The neon lamp such as that used for signs and displays, for example, has its energy concentrated at a few wavelengths, with no energy present in relatively large portions of the spectrum. The sodium lamps, such as those used for street lighting, are again of this type, except, of course, that the wavelengths involved are different.

Intermediate between these and the continuous sources are two somewhat newer types of light source—certain types of the cored carbon theater are and the fluorescent lamp.

These lights have both a continuous spectrum and a high concentration of energy at certain wavelengths. The continuous spectrum of the fluorescent lamp is supplied by the fluorescent materials and the concentrated energy is produced by a mercury vapor discharge, similar in its operation to the somewhat more familiar neon lamp. In the theater are a somewhat similar situation exists, although of course, the distribution is different.

It is seen, then, that light sources vary both in the way in which energy is distributed continuously through the spectrum and also in the way in which relatively large amounts of energy may concentrate in fairly narrow groups of wavelengths. Since light of a given wavelength can be present in the light reflected from an object only if it is present in the source, it is not surprising to find that the energy distribution of the light reflected from a colored object is different if the source is an arc light or a fluorescent lamp, or if it is sunlight. It is different in the same sense as are the lights themselves, being continuous or discontinuous with wavelength as in the source.

The question arises, therefore, as to how the appearance of objects illuminated by these different sources changes as we pass from one to another. In order to understand this, however, it is first necessary to understand how the eye evaluates energy distributions and what factors determine the colors which will be seen.

Color Perception

The eye may be thought of as an optical instrument which has three sensitive receptors very much like those of the three layers of modern photo-

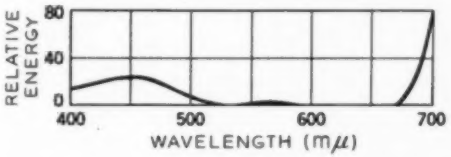


Figure 4. Spectral distribution of the light from the incandescent lamp of figure 2 through the signal glass of figure 3.

graphic color processes. While the sensitivity distributions of such a material are not identical with the sensitivities of the three ordinarily assumed receptors for the eye, the eye does work in an entirely similar manner and we can simply assume that they are identical. What is called the blue sensitivity responds to wavelengths from the extreme short wave end of the visible spectrum down to a point about one-third the distance from the end. The green and red receptors have similarly great ranges in which there is some response so that the sensitivities overlap each other.

When light falls on this group of receptors, the effect of all the wavelengths to which one of the receptors is sensitive adds up. Suppose equal energy light which is visually quite white falls on the three receptors. The blue shortwave light has a little effect on the green receptor, none on the red and a lot on the blue. Now as far as a given receptor is concerned the actual wavelength of light which causes a response does not matter, but only the effective amount of it. The three receptors may be thought of as photocells or photographic emulsions or whatever you will, the action of light of any wavelength on a single receptor is

simply to make it give its characteristic response just as a photocell generates a voltage or a current, a photographic material gets a latent image, etc. The thing that determines the color which will be seen is the *ratio* of the outputs of the three receptors. When the three receptors are excited by light so that the total excitation of each is in a definite ratio each to the other, a perfectly definite color is seen and it does not matter *at all* what the energy distribution of the light may be which causes it. In other words it is only the output of the sensitive elements that matters and not the cause in the form of the exact wavelengths.

This rather surprising state of affairs leads to a series of facts of great importance to color workers since they determine in part the colors which will be seen under a given set of circumstances. The first of these facts is that there are a tremendous number of possible energy distributions which will all look just alike to the eye. The only requirement is that they make the total output of each receptor have the proper relationship to the others. Just as a simple example suppose that equal outputs of the three receptors give the appearance of white. It is apparent that since wavelength does not matter but only the effect on each receptor there are many ways in which the energy distribution of the light may be juggled to get the effect of white. A similar situation exists for any color. It is seen, therefore, first that the appearance of a color gives no idea of its energy distribution and second, that many different energy distributions may look just alike.

Because of these facts it is possible to have light sources which look just alike but which are very different as far as energy distribution is concerned, and the same statement is true of colored objects. Two colored objects may look just alike and yet have very different absorptions for the different wavelengths of light. The important question is not whether their energy distributions are the same but whether they affect the three eye receptors the same.

Now thus far we have considered only the way in which energy distributions are changed by transmitting or reflecting objects, having noted that it is the energy distribution of the final light alone which matters and not the way it is produced. We have also considered the way in which the eye evaluates this energy distribution by means of the three receptors, noting that it is only the relative effect on these three which determines the color seen.

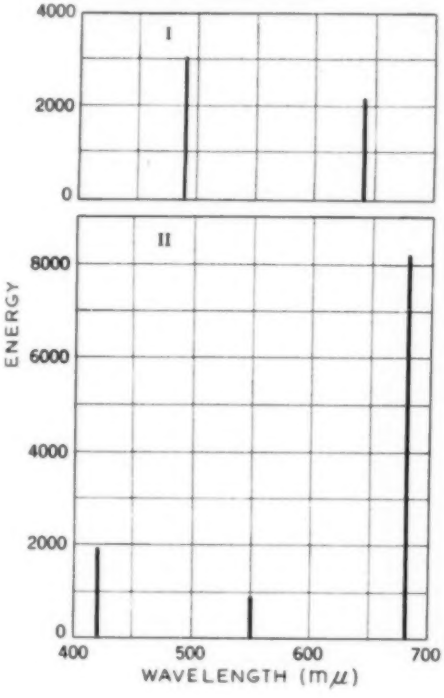
Color Adaptation

Before we try to put these two together it is necessary to consider still another property of the eye. This property is somewhat less well known than the others but, if anything, is more common as an everyday experience. It is known to psychologists as color adaptation. It is a necessary part of understanding the appearance of a color.

When the eye is exposed to a given energy distribution for some time, it becomes accustomed or adapted to that light, in such a way that the appearance of the light changes toward white. The mechanism by which this seems to occur is simply that the eye receptors tend to adjust their *outputs* so that they are all equal whenever light of a given color acts on them for a long time. It is not that their sensitivities to the different wavelengths change but that the output of the blue receptor, for example, goes down if the eye is exposed for a long time to blue light and this blue light tends to be seen more and more as a white as time goes on.

When the eye is in this condition, energy distributions which to the normal eye appeared of one color will now appear different. A light having equal energy at all wavelengths for example will now affect the red and green receptors much more strongly than it does the blue and the net result

Figure 5. Two sets of monochromatic lines that visually match ICI Illuminant C.



will be that it appears not white but yellow. It is also a fact that all other distributions which matched a white before, will now appear yellow also. In other words, all the colors which matched before will still match just as they did before but the color which they all appear to be will be different. The net result of this process in daily life, however, is not that colors *change* when they are taken from one illuminant to another, but that they *tend* to remain *constant* in appearance.

If colored light strikes the eye and you look directly at it, you proceed to adapt to this color. Once this adaptation has taken effect and to the extent that it has, you then tend to see all other colors distorted with respect to this color. For example, if the energy distribution of sunlight is seen at low intensity surrounded by yellow, you will see it as blue. Surrounded by green you would see it as magenta and against a pure blue you would see it as yellow.

This gives, then, three major factors which determine the appearance of a color. They are first, the energy distribution of the light reaching the eye; second, the way the three eye receptors are affected by this energy distribution; and third, the state of these three receptors as determiend by the light to which the eye has become accustomed at the time.

Color Appearance

Perhaps the easiest way to understand how these factors enter into the appearance of colors is to consider increasingly complex particular situations.

Suppose first that lights of *different* colors were to fall in succession on the same group of objects, under conditions which did not permit the eye to change its adaptation. Such an effect is produced if the objects are on a black background, for example. Under these conditions the effect is identical with that of changing the colors of the objects themselves.

The actual colors which appear under these conditions can be determined only by a careful analysis of the energy distribution of the light source and the selective absorption characteristics of the object. There is no *simple* way of predicting the color.

Suppose, for example, that the light source were to have an energy distribution which was divided into two bands, one at the extreme red of the spectrum and one in the blue-green region. Such a light source would look purple since it would affect the blue and red receptors more than it did the green. If this light source is used to illuminate blocks having blue, red, and yellow colors, they could all appear red, a result not to be expected from the visually purple color of the light, but one which could be predicted from a knowledge of the energy distributions involved.

The color seen, under conditions in which the eye does not change, therefore, depends on the energy distribution of the light as affected by the selective absorption of the object and may be predicted from a knowledge of these but not from the visual color of either.

Since there are a great many different energy distributions which appear exactly alike, it follows that the color of an object illuminated by two such distributions which are quite different spectrally may also appear quite different. That is, the fact that the light sources look alike does *not* mean that objects will have the same color under them.

Suppose again that we have two colored solutions or filters or surfaces which under artificial light look approximately alike. Suppose also that these two filters differ in their spectral energy transmissions. One of them transmits some light in the long wavelength region of the spectrum and the other one does not. However, this cannot be seen by a simple visual inspection because the eye does not analyze the spectral distribution but sees only the ratio of the output to the brain of its three receptor system. These colors excite the eye

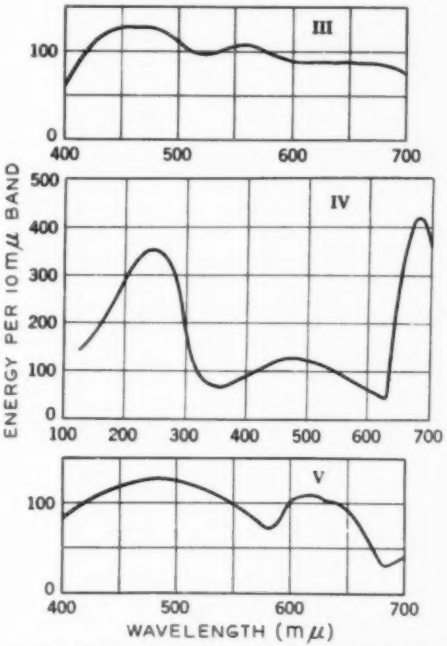


Figure 6. Spectral energy distributions of ICI Illuminant C (top) and of two hypothetical sources that visually match it.

receptors in the same ratio since they match for color.

However, if these same filters are used with a light source in which some wavelengths are decreased in intensity more than others, it is very likely that a difference will become apparent, the size of the difference depending on the region in which the intensity decrease takes place. Such effects cannot be predicted by the visual appearance of the colors involved. Expressed somewhat differently, only the spectrophotometric curve permits prediction of subtractive color effects. This holds whether the colors are due to light sources, transparent colored objects, reflecting colored objects or a sequence of any of them.

Two colored objects which appear alike under one illuminant may or may not appear matched under a different one whether or not the second source has the same color as the first. Fabrics and the like if matched under artificial light, whether of tungsten or fluorescent source, will not, in general, match in daylight or vice versa, except in the rather unusual case in which they happen to be dyed with the same dyes. In this case their selective absorption curves may be identical and they will match under any illuminant of any color or energy distribution. As a matter of fact, samples which match under a wide variety of illuminants are almost certainly dyed with the same dyes and this is a sensitive test to determine that fact.

Two light sources which match visually for color may not show objects as having the same color when each is used separately as an illuminant. If their energy distributions are very different, this effect may be large and noticeable on many colors. It may even be so noticeable that it changes the apparent color of the source. If the difference is slight, it may be noticeable only on certain objects whose selective absorptions make them sensitive to the particular difference between the two sources.

Color Constancy—Limitations of Adaptation

We can turn now to the question, "Since visual adaptation tends to make the light look white, why doesn't it offset the effect of changed energy distributions?"

If one looks at a piece of pale blue paper in daylight, the eyes are adapted to daylight as white, and the energy distribution of the light from the paper has more intensity in the blue than in the green and red. The color appears blue because it causes a higher output from the blue receptor than from the other two. It does this because the sensitivities can be considered approximately equal when the visual mechanism is adapted to light with equal intensities at all wavelengths.

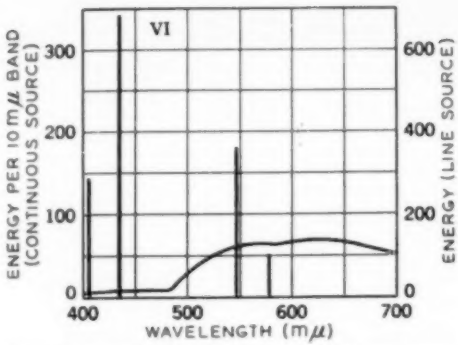


Figure 7. Hypothetical source showing continuous energy distribution with superimposed monochromatic lines.

Now suppose this same paper is viewed in artificial light. Tungsten filament light contains so much more energy in the red than in the blue that the actual light from the paper now has much higher intensity in the red end of the spectrum than in the blue. Such a blue paper, however, still appears blue in incandescent light. The reason for this is that the eye is now adapted to the artificial light as white, and while the artificial light may have seven or eight times as much energy in the red as in the blue, this adaptation makes it still appear nearly white. That is, the red receptor has approximately one-eighth the *output* that it had before, relative to the blue. The light coming from the blue paper, however, has less than this ratio of red to blue and so it still excites the blue receptor *more* than the red and is accordingly *seen* as blue.

To this extent, then, adaptation *does* offset the changed energy distribution. This adaptation effect has very definite limitations, however, because of the way in which the adaptation takes place over a whole third of the spectrum for each receptor rather than wavelength by wavelength. For a color which with the light source gives an energy distribution such as that given by most blue papers, in which the relative energy changes quite gradually with wavelength, adjustment of the receptor outputs in blocks of a third of the spectrum so that the illuminant produces equal outputs from each receptor leaves the energy distribution such that it excites the blue receptor more than the other two.

Suppose, however, that the same illuminant was used, but an imaginary reflecting object was placed in its path which reflected light at one wavelength only and absorbed all others. Adaptation to the light source would change the receptor outputs as before but the object *would still reflect only the one wavelength*. Since such a wavelength might af-

fect at least two receptors, a very decided change in color might be seen. The ratio of outputs of the receptors would have changed but the exciting light would not have been changed by the change in illuminant.

This kind of a reflecting surface, of course, is not common enough so that large effects of this type are well known. Some interference phenomena and the like do produce such reflections and anyone can see the effects if he has a source of monochromatic light. There are, however, many intermediate types of reflecting and transmitting objects which do show large and important changes. In general these are objects dyed with what is known as sharp cutting dyes. Suppose, for example, we have a dye which transmits partially in the blue third of the spectrum, absorbs heavily through the green and part of the red region, and then has a high transmission in the far red. Such a dye might be a clear blue in daylight, especially if it reflected much blue light, because of the importance of the transmission at the short blue wavelengths.

If a person's vision is adapted to artificial incandescent light and in this state he looks at the dye, he may see purple and not blue. The reason for this is exactly the same as for the monochromatic light. The ratio of sensitivities of the receptors, while they change in the right *direction* to correct the color back to a blue, do not change by the required amounts because the light source distribution has a gradual change with wavelength while the dye absorption shows abrupt changes.

Colors showing this sort of change are quite common. They are known under various names such as "sensitive" and "unstable" colors. They are familiar in articles of clothing which change their color noticeably from daylight to tungsten light.

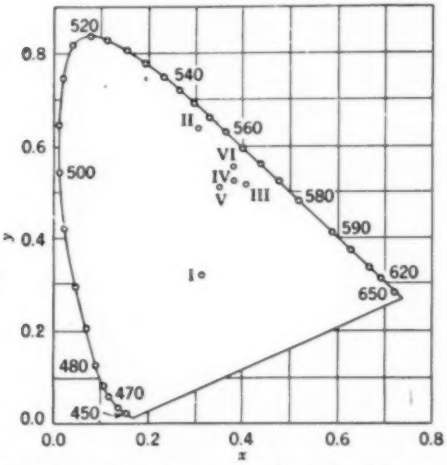


Figure 8. Spectrophotometric reflectance distribution of a surface.

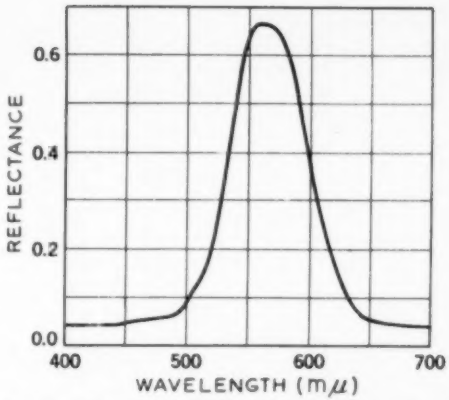


Figure 9. Points on an ICI chromaticity diagram corresponding to the light reflected from the surface of figure 8 by the various illuminants illustrated in figures 5 through 7. The approximate Munsell notations for these colors are: I. N3; II. 10GY 8/20; III. 4GY 7/11; IV. 6GY 7/11; V. 4GY 7/10; VI. 6GY 8/14.

Most of the colors in everyday life, however, have the gradually changing type of absorption curve more similar to the pale blue paper. Adaptation adjustment of the receptors for the illuminant in these cases is sufficient to give closely the daylight visual color of the object. It is for this reason that the objects appear to have more or less constant surface colors in spite of the fact that the energy distribution of the light which they reflect necessarily changes with that of the illuminant. Hence the common expressions "the color of an object," "a green object," etc.

Factors Introduced by Today's Electric Discharge Sources

There is one type of situation, however, in which this "color constancy effect," as psychologists call it, does not operate even with ordinary colored objects. These are the situations in which the illuminant itself, instead of having a smooth, gradually changing energy distribution, either does not give off any energy at all over certain wavelength regions, or else has high concentrations of energy at certain wavelengths. This sort of light source is becoming more and more common with the progress of science and this can be expected to go considerably further. Examples of the first type are the familiar sodium street lights, Cooper Hewitt mercury arcs, neon signs, etc. In the latter category come motion picture flame arcs, high pressure

mercury lights, and fluorescent lamps, each of these having continuous spectra but high concentrations of energy at certain wavelengths.

The ratio of sensitivities reached after adaptation to a light source *depends only on the visual color* of that source because the visual color is determined by the ratio in which it excites the receptors and this also determines the adaptation. If a source of either of these types, therefore, is the general illuminant for a room or scene, the amount of *adaptation* it will produce is exactly the same as for a light of the same color but having a smooth curve. The correction which the eye will make for the colors of objects therefore will be the same and will not offset *at all* the color changes produced by the changed energy distribution of the source. The appearance of most surfaces will be different from normal experience.

Consider an extreme example for illustration. Suppose two light sources match visually. One of them is ordinary incandescent light and the other consists of two spectrum lines, one in the blue-green region and one in the orange-red. Objects which are not normally gray will look very different under the two line source than under the other, in spite of the fact that the visual adaptation is exactly the same in the two cases. All objects which do not reflect the blue-green line will appear red and all objects which do not reflect the red one will appear blue-green. Object colors will bear no particular resemblance to their colors in daylight or in artificial light. Yellow and orange objects, for example, would be red and a very pure green would be black as would a red which reflected only the longest wavelengths because neither of these would reflect either wavelength.

An object examined in daylight and then taken into a room lighted by the two line source would show no color constancy at all and might change to an entirely different color, even though in an artificial light which appeared to be the same color it might look nearly the same as in daylight.

This extreme case illustrates the point and is admittedly extreme. This does not mean, however, that such effects are not common because to a greater or lesser extent they occur under all the sources which have been mentioned. The most common very extreme light source, of course, is the sodium street light under which only yellow is visible regardless of the daylight color of the object. Perhaps the least extreme are the high intensity flame arc and fluorescent lights. Colored motion pictures which are to be projected only on such an arc can be corrected for the arc distribution provided the pictures are not to be projected also by incandescent light. Because of the absence of long wavelength red light, this is not true for the more popular types of fluorescent lights. Changes in natural objects and color photographs produced by these lights are familiar facts. A new fluorescent lamp has been developed recently which when properly used corrects the situation for color photographs.

We have seen, therefore, that when light from a source falls on one or more colored objects either separately or in succession we are dealing with successive absorptions of energy. At each step in the process if the light is viewed by an observer he evaluates this energy distribution by three specialized receptors in a definite adaptation state and sees a color determined by the ratios of their outputs. Because of this fact it is not *possible* for the observer to predict the result of the next step from the color which he sees.

A knowledge of the exact energy distribution in the source and the wavelength absorption distribution properties of each object *does* permit such a prediction and this is the only way it can be done.

Louverall lighting of a Boston store window from ceiling units; 275 ft-c from fluorescent plus 200 ft-c from incandescent spots. Architect: George L. Ely. Engineers: Fullerton Manufacturing Corporation. Contractors: F. J. Lawson Electric Company. Photo courtesy Boston Edison Company, through Electric Institute of Boston, Inc.

Lighting a Subway Car

LIGHTING OBJECTIVE: To illuminate a subway car so as to provide a pleasing environment with uniform illumination, low brightness ratios, attractive color treatment, and to facilitate reading conditions.

Installation in a subway car for BMT-IND division New York Board of Transportation, New York City, New York.

General Information: The new subway cars built by the American Car and Foundry Company Company for the New York Board of Transportation are in two different sizes, but the lighting layouts are similar. The car illustrated is 58 feet long, 9½ feet wide, with an arched roof averaging 7½ feet. Interiors of this area range from 82 per cent reflectance white roof to a 35 per cent reflectance gray upper side-wall, and 13 per cent reflectance blue lower-wall. The seat cushions are light straw in color and floors dark gray. Windows form a large percentage of the wall area and contribute little to light utilization.

The cars are served by 625 volts d-c from a third rail, the power being frequently interrupted due to track crossovers and similar breaks. The lighting for each car is controlled locally although the destination signs are wired so that they may be remotely controlled from the motor-man's cab. All cars are symmetrical, and without seating change can be operated in either direction.

Installation: A completely enclosed unit was considered necessary, partially because of brightness distribution goals and partially because an extended fluorescent lamp would be too similar to hand rails for standing passengers. The final choice was a fixture made by Luminator, Inc., with prismatic bottom and diffusing side sections producing an emphasis on down lighting but with ample distribution for acceptable brightness patterns.

The fluorescent light sources used for this application are as follows:

Interior Lighting

Lamp Type	*Color*	*Current*	*Lamp Watts*	*Life*
72″ T-8 cold cathode heavy duty	soft-white	110 ma	36	8000 hours
48″ T-8 cold cathode heavy duty	soft-white	110 ma	28	8000 hours
Destination Sign				
28″ T-8 cold cathode heavy duty	green	110 ma	21	8000 hours

To adapt these lamps for 624-volt d-c operation, a special d-c starter and resistor ballast are provided for each lamp. Lamps of soft-white color were chosen because of the red component which it was felt would be flattering to complexions. Illumination readings for 3500K white fluorescent lamps would be 15 per cent higher because of higher output. To prevent mercury drift in the lamps which occurs when current flow of fluorescent lamps is uni-directional, provision is made for reversing the polarity at the end of each run (seldom longer than two hours).

(over)

A.I.A. File No. 31 f 11

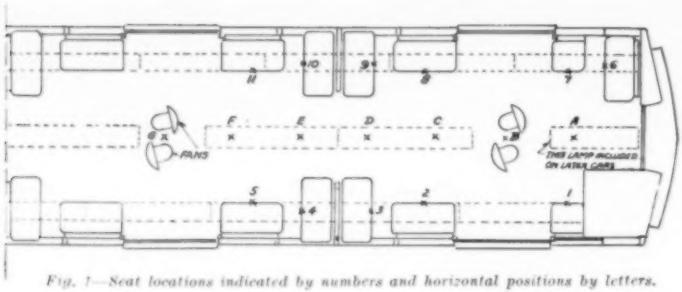


Fig. 1—Seat locations indicated by numbers and horizontal positions by letters.

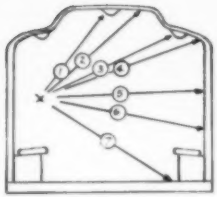


Fig. 2—Stations for brightness measurements.

Expected depreciation for the lamps is approximately 68 per cent at 70 per cent of life. Recent measurements in car No. 1575 indicate a somewhat greater depreciation. These lamps were engineering samples which would not be indicative of the performance expected of production lamps. The glass panel of the fixture is gasket sealed to the reflector and it is expected that the depreciation will be very low. Inspection of the fixtures after six months' operation indicates that they are well sealed against dirt collection.

Equipment furnished per car consisted of the following:

18 luminaires using 2 48-inch lamps
6 luminaires using 2 72-inch lamps

As shown in Fig. 1, the seating arrangement of the larger car is both parallel and perpendicular to the car axis and illumination values vary depending upon the seat position being measured. Using the American Transit Association standard of an average reading plane 33 inches above the car floor and inclined 45 degrees toward the seat, illumination values for the positions marked in Fig. 1 are as follows:

Seat Position	*Illumination on Reading Plane*
2–8	16.4
3–9	20.0
4–10	20.0
5–11	17.2
1–6	10.5 (see paragraph below)

These measurements were taken at 100 hours on the first car completed. (As indicated in Fig. 1, an additional 48-inch lamp has since been added to increase the illumination at each end section of a car.) Readings were taken with a color corrected meter. To correct for the deviation due to the error of readings of light received at wide angles, the above values should be increased approximately 5 per cent. General illumination distribution is indicated by horizontal readings taken three feet above the floor along the center line of the car. These readings averaged approximately 19 footcandles. The illumination for a standing passenger was approximately 29 foot-candles at five feet above the floor along the center line of the car while the advertising cards were lighted to a level between four to six footcandles.

Brightness values are an indication of lighting comfort and readings were taken as shown in Fig. 2 from both a longitudinal position and from across the car. Readings are tabulated below for positions shown in Fig. 2.

Position	*Surface*	*Brightness*
1	Central Fixture	157 Ft L
2	CCeiling	3
3	Side Fixture	128
4	Car Card	3
5	Gray Side Wall	4
6	Back of Seat	4
7	Floor	2

While these do not approach ideal standards of 3 to 1 for continuous seeing, there is a marked improvement over the present subway cars having 20,000 to 1 values for bare incandescent lamps.

Lighting data submitted by Sylvania Electric Products, Inc., Salem, Massachusetts, as an example of good practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society,
51 Madison Avenue, New York 10, N. Y.

Series XIV 1-49

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Review of Council Action at December Meeting, New York

The second regular Council meeting of this administration was held at Society headquarters December 8. Some of the action taken of more general interest to the membership is noted below. Present at the meeting were: Lee E. Tayler, President; C. H. Goddard and Walter Sturrock, Vice-Presidents; A. H. Manwaring, General Secretary; E. M. Strong, Treasurer; Myrtle Fahsbender, Carter Lewis, A. E. Parker, Hoyt P. Steele, and M. N. Waterman, Directors; G. W. Beals, Joe E. Browder, Harry Grattan, Jr., Duncan M. Jones, Edwin H. Lauth, and William A. Stannard, Regional Vice-Presidents; A. D. Hinckley, Executive Secretary; C. L. Crouch, Technical Director; G. Ross Henninger, Director of Publications; Ruby Redford, Production Editor; and R. F. Hartenstein, S. G. Hibben, J. M. Hickerson, E. C. Huerkamp, C. C. Keller, R. C. Kinney, J. S. Schuchert, J. M. Stedman, George J. Taylor.

New Members Emeritus

In his report of the General Board of Examiners, R. T. Kinney, chairman, submitted the recommendation of his committee on the election to Member Emeritus of J. L. Stair and Dr. W. R. Whitney, long-time members of the Society. By unanimous action of Council both these valued members were elected to Member Emeritus.

J. L. Stair, Fellow and Member Emeritus

Mr. Stair has been chosen before for distinction in the Illuminating Engineering Society. In addition to invaluable service to the Society through numerous committee assignments and through his many contributions to the *Transactions*, Mr. Stair served the Society in 1933-1934 as President. In 1945 he was elected a Fellow of the Society in recognition of his distinguished work not only in the I.E.S. but in the lighting industry as well. Mr. Stair for many years was a leader in the industry in his connection with the Curtis Lighting Co. of Chicago, from which he retired recently.

Dr. W. R. Whitney, Member Emeritus

Dr. Willis Rodney Whitney is widely and justly acclaimed as the Dean of industrial research. He founded and developed the first industrial laboratory in this country dedicated primarily to basic research. During his 32 years as its Director, that laboratory achieved a world-wide reputation for its contributions both to the advancement of scientific knowledge and to the development of the electrical industry. Many of these contributions were in the field of illumination. His individual work produced the metallized carbon filament or "Gem" lamp, which constituted the first important advance in efficiency over the carbon filament lamp of Edison's.

All branches of the electrical industry have benefited largely from the work of Whitney's Laboratory, but none more greatly than the illuminating field.

Membership Figures

Reporting further for the Board of Examiners, Mr. Kinney recommended to I.E.S. membership the election and transfer of ten Members, the election and reinstatement of 47 Associate Members, and the election of nine new student members. Elections and other changes resulted in current membership figures as shown in the following tabulation:

October 13, 1948		December 8, 1948
6,644	Total Members	6,666
22	Members Emeritus	25
44	Fellows	42
1,425	Members	1,442
5,013	Associate Members	4,988
140	Student Members	169

Society's Finances

In the discussion following the report on facts and figures of the Society's finances, it was noted that I.E.S. operating costs now total some $9000.00 per year.

Public Relations

From the report by Mel Hickerson, new chairman of the Committee on Public Relations and Information, it is interesting to note that the Society is assuming a more progressive attitude toward public information on its important activities. Mr. Hickerson presented two prospective plans in this connection, one more elaborate, one less pretentious in nature. Definite proposals approved by Council included:

I.E.S. display booth at the Third International Exposition.

New booklet on I.E.S. services.

Other proposals to be discussed further included (1) promotion of illuminating engineering courses in colleges with definite prospective jobs offered and reliable indication regarding future careers; (2) press luncheons to acquaint press with I.E.S. activities; (3) stimulation of local publicity activities.

New Policy on Publication of Conference Papers

E. C. Huerkamp, Chairman of the Publications Committee, in reporting status of the new ILLUMINATING ENGINEERING, and its future problems, asked for a clarification of policy on publishing Conference papers. After considerable discussion, Council approved that Conference papers accepted and approved by the Papers Committee will be pubished in ILLUMINATING ENGINEERING either in full or condensed, any such condensing to be with the approval of both the author and the Papers Committee.

Sustaining Membership

George J. Taylor, Chairman, reported to Council on the present activity underway by the Sustaining

Membership Committee. He reported the previously approved goal of $25,000,00 increase, 54% reached. Mr. Taylor urged the preparation of a brochure outlining Society's services; the cooperation of Regional Vice-Presidents in the "drive"; and individual membership aid. Mr. Taylor agreed to prepare a letter to Regional Vice-Presidents explaining the basis of the present need, and benefit of sustaining membership for their information to prospective members.

French Lick Conference Plans

A report of the Conference Committee's plans to date on the French Lick Conference was outlined by R. F. Hortenstein, Chairman. The program outline approved by Council was:

Tues. a.m., Sept. 20—Opening
Tues aft., Sept. 20—Technical Session
Wed. a.m., Sept. 21—Parallel Sessions
Residence Lighting Forums and Residence Lighting Technical Sessions
Wed. aft., Sept. 21—Recreation
Wed. eve., Sept. 21—Progress Report
Thurs. a.m., Sept. 22—Technical Sess.
Thurs. aft., Sept. 22—Technical Sess.
Thurs. eve., Sept. 22—Banquet
Fri. a.m., Sept. 23—Technical Session
Fri. aft., Sept. 23—Technical Session
Adjourn Friday 4:30 p.m.

Mr. Hartenstein noted that a complete program will be sent to all committee chairmen so that committee meetings held during the conference will not parallel pertinent technical sessions. He stressed that all committee meetings to be held should clear through the Conference Committee.

Mr. Hartenstein initiated a discussion on the time and nature of the Lighting Service Forum. He noted that a full-day session will not be possible because of train connections and arrival times at French Lick and suggested that a half-day session on Tuesday morning be devoted to the Lighting Service Forum.

In a discussion on the nature of the Forum and its relation to the Conference, it was established that the Lighting Service Forum is *not* a part of the Technical Conference Program.

Proposed Society Projects

In a report of the Project Planning Committee, J. S. Schuchert proposed for future Society activities:

1. The sale and distribution of I.E.S. Recommended Practices and Standards. The Committee suggested that the new School Lighting Practice be used experimentally for such a project, each Section and Chapter being asked to devote one meeting to discussion and promotion of it.

2. That Lighting Data Sheets be publicized more. That similar Chapter programs be devoted to Data Sheets, that competitions for winning data sheet material be established.

3. That funds be allocated to technical committees to cover expenses for services not covered by any other means.

4. That a separate technical committee be set up for the study of lighting of generating plants, if possible a joint committee with E.E.I. or other interested groups.

5. The formation of a Committee on Society History was recommended, with S. G. Hibben as official historian.

6. That an Advisory Committee on Personnel be set up to assist the President in appointments. This to consist of not more than five people to survey personnel possibilities.

On proposition No. 4, it was approved that a committee be formed to study lighting of central station properties and that a letter ballot on scope be circulated.

Local Activities

Walter Sturrock, Chairman, reported the appointment of 31 new Local Representatives. He further reported that while there are some 100 Local Representatives throughout the country, territorial coverage is decidedly uneven. He suggested that a Local Representative be located in any city over 1,000 population. He felt further, that Section and Chapter boundaries should be revised to incorporate all territory in the United States and Canada, and that a uniform rule should be adopted for the operation of Local Representatives, who cooperate with a specific Section or Chapter. Mr. Sturrock also suggested further study of regional boundaries.

Manual-Type Handbook Rejected

In a prolonged discussion of the possibility of I.E.S. publishing a pocket-size lighting manual, the motion proposing this project was lost by lack of majority vote in a show of hands.

Technical Committee Reports Approved

Of three technical Committee reports presented to Council the following were approved by Council as recommended lighting practice to be published by the Illuminating Engineering Society:

1. Lighting for Woolen and Worsted Textile Mills, 1948.

2. Revision of Recommended Practice of Lamps for Aviation Lighting.

Toronto Section Lighting Forum

A forum on "What Lamps to Use" was a special extra-curricular meeting featured recently by the Toronto Section. Three featured speakers discussed incandescent lamps, hot and cold cathode fluorescent lamps, mercury and sodium lamps. Speakers were W. Hardman, Service Lamp Co., London, Ontario; J. W. Bateman, Canadian General Electric Co., Toronto and G. F. Mudgett, Canadian Westinghouse, Toronto.

The speakers traced the developments in the various types of lamps, outlining the application and limitations of each.

Coincidentally, the meeting was held on the 30th anniversary of a meeting held in 1918 in Toronto from which evolved the present I.E.S. Section there.

I.E.S. Lighting Courses Underway

A number of lighting courses sponsored by I.E.S. Sections and Chapters are currently underway with great success across the country. Those reported to headquarters to date include:

New York Section—New York University advanced lighting course. As previously reported, the N. Y. University has this year taken over the Section's courses in lighting, as part of their regular Extension Course curricula, with the cooperation of the Section and with Section members as lecturers. The fundamentals course at N.Y.U. has just been completed, and the advanced course in lighting design problems is now beginning.

Twin City Section is co-sponsor with the William Hood Dunwoody Industrial Institute of Minneapolis of a three-hour night class in "Fundamentals of Illumination." The course will run for 20 sessions following the general plan of the I.E.S. course. Three

additional sessions are expected to be added devoted to tours and study and analysis of actual installations. The slide film set recently prepared by Westinghouse is used as a visual aid in the course. S. F. McGowan of the Twin City Section is instructor.

Western New York Section course on "Elements of Electric Wiring and Illumination." This is a short non-technical course in the practical elements of electrical wiring and illumination for members of the architectural profession and their associates. It comprises six discussion type meetings, planned with the specific requirements of the architect in mind. Sessions cover: (1) The power company's service and requirements for electrical installation. (2) The elements of electrical wiring design and installation with their relation to the National Electrical Code. (3) The basic requirements for effective lighting for working and merchandising with the elements of lighting design embodying these principles.

Philadelphia Section Advanced Design Round Table. The first meeting of this extended course was held December 6, covering "Performance and Use of Processed Incandescent Lamps."

Northern California Section evening course in Practical Illumination. This is a "three way" course held alternate days in San Francisco, Oakland and Sacramento with each of the 12 sessions repeated on following nights in these cities. Enrollment is limited to I.E.S. members in each city. The 12 two-hour sessions are combined visual and lecture courses, with leading lighting experts of the Northern California Section serving as instructors.

Montreal Section Store Lighting Forum

The first of a series of special "lighting and industry" meetings being sponsored by the Montreal Section featured a Store Lighting Forum held at the Henry Morgan store in Montreal. Guests of the Forum included store representatives, architects and interior designers from all parts of Quebec Province.

The object of the proposed series of talks is to acquaint the users of lighting in various fields of activity with the art and science of illuminating engineering and the desirability of having qualified lighting engineers working in conjunction with the architects, interior designers and decorators to obtain the most satisfactory results.

The worth of the idea was evident from the success of the store lighting forum. All forms of lighting from crystal chandeliers to the latest technique in louverall lighting are in use at the Morgan store. In addition to touring the entire store, the group heard the following discussion program:

An introduction to the Society's latest publication on store lighting, "Lighting Practices for Stores and Other Merchandising Areas."

"Basic Principles of Store Lighting" by Duncan M. Jones, Canadian Regional Vice-President, I.E.S.

"The Henry Morgan Lighting Programme" by H. M. Yuile, store maintenance engineer of Henry Morgan Co. Ltd.

Back Issues Needed

Back issues of the *Transactions* and ILLUMINATING ENGINEERING are being sought by Professor Charles H. Murrish of the University of Buffalo. Professor Murrish, Instructor in Engineering there, is interested in acquiring back issues from 1906 to September, 1946. If any I.E.S. member can assist him in this connection, it would be appreciated if he would write to Professor Charles H. Murrish, The University of Buffalo, School of Engineering, Department of Electrical Engineering, Buffalo 14, N. Y.

I. E. S. Aviation Committee Meets at Arcata

A good deal of the I.E.S. committee work carried on throughout the year is of great benefit to the public welfare, but perhaps none is so tangible a contribution as that of the Aviation Lighting Committee and their work on the safe landing of aircraft. Almost the entire committee, and a number of interested guests, met recently at Arcata, California to study methods of all-weather approach and runway lighting. Their meeting made headlines all over the country.

Hosts to the 30 I.E.S. committee members and guests at their three-day meeting was the Air Force-Navy Civil Landing Aids Experiment Station, operated by Transocean for their armed forces and civil sponsors. Located in what is known to be the most fog-bound airport in the world, the station is devoted to the study and evaluation of all-weather landing aids.

One of the committee's major interests coincides exactly with the visual aids work being carried on so capably by the station. As Ralph R. Brady, chairman of the I.E.S. Committee, outlined to the newspaper reporters covering his committee meeting, "We are specifically interested in providing visual, or lighting, aids to enable aircraft to make safe, on-time landings under adverse weather conditions — such aids to supplement, not supplant instrument and electronics aids.

"On the simple and age-old basis that 'what goes up must come down,' it is easy to see why aviation is so dependent upon aids to landing which are effective under any and all visibility conditions. Under normal visibility conditions, landing is routine. That is emphatically not the case when the military, civilian or commercial pilot must find the airport when it's blanketed by fog. At such a time, he must depend upon effective, certain, and as nearly as possible, fool-proof landing aids — his radio communications and navigation aids, his instruments, instrument landing system, ground control approach, FIDO, approach and runway lights, and so on.

"With aviation finally come of age and standing on the threshold of yet more startling progress, it is more vital than ever before that effective, sure, visual landing aids be provided. Our visit here is truly an eye-opener, for probably at no other single place in the world could we observe the installation and operation of so many approach and runway lighting systems.

"Aviation people all over the world are vitally interested in this station and its studies and findings. Here are being found those landing aids which will finally make tomorrow's flying so safe, so sure, that when the weatherman says, 'Ceiling zero, visibility zero,' any pilot can nonchalantly ask: 'so what?'"

Assisting in conducting the meeting were Lewis B. Moore, vice-chairman, of Urbana, O.; and David C. Miller of Cleveland, O., secretary. Committee members present also included H. J. Cory Pearson of the Civil Aeronautics administration, Indianapolis, Ind.; Frank B. Brady of the Air Transport Association, Washington,

D. C.; Frank C. Breckenbridge, National Bureau of Standards, Washington, D. C.; John P. Hoxie, Corning, N. Y.; William A. Pennow, Cleveland, O., and Raymond A. Rugge, Columbus, O.

With as little time as possible spent on routine business sessions, committee members made aerial observations of the station's many lighting systems. Further such observations were followed by a round table discussion of the various systems and their apparent advantages, with no effort at evaluation pending further studies.

Adopt Code of Ethics

Mindful of the large number of young men preparing for the engineering profession, the Engineers' Council for Professional Development has adopted a "Canons of Ethics for Engineers," especially to serve as a moral guide to young engineers as they progressively assume professional responsibility. The Canons supplement the engineering tradition of honest public service and the example of professional leaders. So effective has been the unwritten moral code of the profession that many engineers opposed at first the suggestion that a formal code was needed and cited the low incidence of unethical practice among engineers. Some felt the Golden Rule was all that was needed. Since its recent adoption by ECPD, however, more than 25 national and local engineering societies and councils have incorporated the Canons as part of their constitutions.

Increasing support has come from engineers concerned lest union appeals for the sympathy of the young graduate should lead them away from the established paths of professional development.

Based on Christian ethics, the Canons spell out the relationship of the engineer to his client, his employer, and the public. "The keystone of professional conduct," the Canons state, is "integrity." The engineer must "interest himself in public welfare and be ready to apply his special knowledge to the benefit of mankind."

In his relations with the public, the engineer is directed to extend "public knowledge of engineering" and to discourage "the spreading of untrue, unfair, and exaggerated statements regarding engineering."

"He will express an opinion only when it is founded on adequate knowledge and honest conviction while he is serving as a witness before a court, commission, or other tribunal."

In his relations with clients and employers, he will "act as a faithful agent and trustee. He will disclose no information concerning the business affairs or technical processes of clients or employers without their consent."

"He will not be financially interested in the bids as or of a contractor on competitive work for which he is employed as an engineer unless he has the consent of his client and employer."

The Canons direct that in his relations with his colleagues in the profession, "He will take care that credit for engineering work is given to those to whom credit is properly due. He will endeavor to provide opportunity for the professional development and advancement of engineers in his employ. He will not become associated in responsibility for work with engineers who do not conform to ethical practices."

The Canons have been attractively printed on a $9\frac{1}{2}$ x 14 inch card for framing and in the standard $8\frac{1}{2}$ x 11 inch size for general distribution to the engineering schools and professional societies. The large size is in two colors and sells for fifty cents per copy. The smaller size sells for ten cents per copy, or five cents when purchased in bulk. Copies may be obtained through the Engineers Council for Professional Development, 29 West 39th St., New York 18, N. Y.

LIGHTING EXPERTS INSPECT RADAR AID TO BLIND LANDING — Members and guests of the Illuminating Engineering Society's Committee on Aviation Lighting inspected numerous aids to all-weather landing recently at the Landing Aids Experiment Station at Arcata, Calif. Operated by Transocean Air Lines for its Air Force-Navy-Civil sponsors, the Station was host to the IES Committee during a recent three-day meeting. The photo above shows a group of the lighting experts ready to inspect radar equipment comprising the "GCA"—ground controlled approach—system. Left to right: John S. Haney, Syracuse, N. Y.; H. J. Cory Pearson, Indianapolis, Ind.; Ralph R. Brady, Bloomfield, N. J., IES Committee chairman; F. E. Gilbert, Los Angeles, Calif.; J. A. Wiseman, Ottawa, Canada; M. A. Warskow, New York, N. Y.; J. J. Green, Ottawa, Canada; H. D. Cameron, Ottawa, Canada; Frank C. Breckenridge, Washington, D. C.; J. P. Wilson, Ottawa, Canada; H. F. Hillis, Washington, D. C.; G. W. Johnson, Palo Alto, Calif.; L. B. Moore, Urbana, O., I.E.S. Committee Vice-Chairman; John P. Hoxie, Corning, N. Y.; R. A. Rugge, Columbus O.; David C. Miller, Cleveland, O., secretary of the I.E.S. Committee, and W. H. Smith of Spokane, Wash.

Central Bureau, I.C.I. Moves to America

News of great significance to illumination, particularly in this country, is the election by the International Commission on Illumination of Carlyle A. Atherton of New York City as Honorary Secretary of the Commission. Mr. Atherton's election transfers to America, Central Bureau activities of this distinguished body.

As Honorary Secretary, Mr. Atherton succeeds the late Sir Clifford Paterson of London who was the guiding spirit of this great work for the past 33 years. As the first American Secretary, Mr. Atherton succeeds to a position served in the past with great distinction. The Central Bureau, in its location in America, similarly succeeds to the most notable work done in the past by the European countries, and in particular the British, on fundamental international illumination principles.

It is worthwhile recording some of the many important basic points in the science of lighting have been established by the Commission in its 36-year history. The standard sensitivity curve of the eye, for instance, was developed by international agreement through the Commission. The basis of Colorimetry, which is accepted by people all over the world, is their accomplishment. The definition of the three primary colors, and the method of putting these together to define the color of light, was established by I.C.I. The fundamental work on the establishment of the new candle, which is the radiation of a square centimeter of platinum at the temperature at which it freezes, is the work of I.C.I.

Such matters as the international standardization of the lighting of the airplane and airfields throughout the world, standardization of automobile headlight distribution, among numerous others, have been international agreements of tremendous importance achieved by the I.C.I.

Asked in an interview the future trend of the Central Bureau's work, Mr. Atherton stated that he intends to use all the influence he can to make the Commission the central organ of the world for the promotion of a consciousness of lighting as a social and economic factor in the welfare of mankind. He feels deeply that there is a world-wide mission to be accomplished by lighting—for schools, for offices, for factories, for public safety and for public welfare in innumerable respects. He believes that the vast experience of the Illuminating Engineering Societies here and abroad will be a useful background for this aim.

C. A. Atherton
Honorary Secretary, I.C.I.

Another important trend in the operation of the Commission will probably be the development of the I.C.I. Congress in its widest sense. The international exchange of information on up-to-date lighting practices, open discussion, and the presentation of papers from all over the world, are expected to provide great stimulus to lighting as a beneficial world-wide social factor.

In its American location, the Central Bureau of I.C.I. will be at 8 East 79th Street, care of Electrical Testing Laboratories, Inc., New York City. Mr. R. J. Whitney of the International General Electric Co. is the new General Secretary to I.C.I. Mr. Whitney has had a great deal of experience in the organization of international technical work, conducting of international meetings and the codification of their minutes and decisions.

Mr. Atherton, the new Honorary Secretary of the International Commission on Illumination, is a graduate of Worcester Polytechnic Institute. He is well-known internationally for his work for many years as Technical Director of Phoebus (an international group of lamp manufacturers) in Geneva, Switzerland. Since his return to this country at the outbreak of World War II, Mr. Atherton has been active in the work of the Illuminating Engineering Society here, serving on numerous important committees, and most notably as chairman of the Lighting Handbook Committee, which produced in 1947 the first complete handbook on lighting data, design and application. Mr. Atherton is now associated with the Westinghouse International Co., New York City.

A. A. Brainerd

U. S. National Committee I.C.I. Elects New Officers

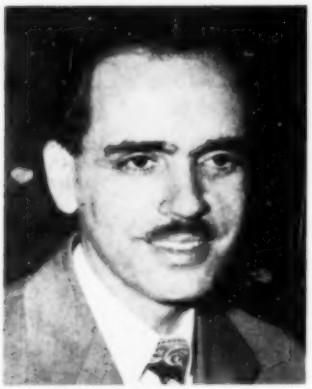
At the annual meeting of the U. S. National Committee of I.C.I., held in New York last November 17, the following officers were elected for the ensuing year:

President—Arthur A. Brainerd
Vice-President—Willard C. Brown
Treasurer—Rudolf W. Staud
Secretary—Louis E. Barbrow

All of the newly-elected officers of the U. S. Committee of I.C.I. are leaders in the lighting field in the United States and in the work of the Illuminating Engineering Society. Mr. Brainerd, newly-elected President, has contributed greatly to the furtherance of lighting practice in this country, presenting numerous papers on his original researches in industrial lighting, the relation of color to lighting and vision in the factory, testing procedures, school lighting, and many others, before the Illuminating Engineering Society and in the trade press. He has filled many important committee assignments for I.E.S., and has been active in the work of the U. S. National Committee of I.C.I. since 1932 when he was made U. S. Representative on the committee on Diffusing Materials and Light Distribution. In this capacity he represented the United States when the present five-division classification of luminaires was agreed upon.

W. C. Brown

R. W. Staud



L. E. Barbrow

In 1938 Mr. Brainerd was made Executive Secretary of the United States National Committee and in 1947, Secretary-Treasurer. He attended the 1939 Sessions of the I.C.I. in Scheveningen, Holland, where he presented a paper on "Studies in Actual Seeing Problems in Schools and the Effect of Lighting on Scholarship," and was present also at the recent I.C.I. Session in Paris, France.

Student Chapter at University of Illinois

Acting under the new Constitutional provision, the Executive Committee, at its October meeting, recommended authorization for the Society's first Student Chapter. The new Chapter has been developed through the very active interest in illumination at the University of Illinois, centered on the teachings of Prof. J. O. Kraehenbuehl, who has served as the Society's Local Representative at Urbana for a number of years. In this capacity he will be the Student Chapter's Faculty Adviser. With an estimated strength of over 60 students, the group has held 5 meetings since January, 1948, with an average attendance of 44 students, the majority of whom are student members of the Society. The first officers are: L. L. Shepherd, Chairman; R. E. Birr, Secretary-Treasurer; S. L. Burnham, Manager; R. E. Hintz, Manager.

Officers of the Chicago Section have evidenced an active interest in this new Chapter and are planning to cooperate fully with this special group, which falls in the area served by the Chicago Section.

Members of the Society at the University of Illinois who can assist with the new Student Chapter include: W. W. Hinshaw, H. W. Horn, W. E. Miller, B. Smith, Jr., and H. W. Waldo.

Twin City Lighting Design Competition

The Twin City Section of the Illuminating Engineering Society is sponsoring a prize lighting design competition for the students in the School of Architecture at the University of Minnesota. The Board of Managers of the Section proposes to have this a continuing project and that one each year be offered to the students.

A prize fund of $100.00 has been proposed, with instructions that a portion of the prizes for students be Student Membership in I.E.S.

The purpose of the project is to develop a greater understanding of the application of lighting in architecture. The program for the problem will be written by the faculty at the University with members of the Illuminating Engineering Society acting as consultants. The Section I.E.S. members will also be asked for criticisms during the progress of the problem.

Mr. R. C. Jones, Head of the School of Architecture; Mr. Winston Close and Mr. Robert Cerny, Assistant Professors and practicing architects, have already set up plans for the first program. This will be a medical center tentatively to be constructed on a site in Minneapolis. It was felt that a building of this type would embody many principles in lighting and force the students to exercise a great deal of ingenuity. There will be doctors' offices, auditoriums, consultation rooms, etc., involved.

Twin City School Lighting Committee Reports

After more than a year's study and analysis of the lighting conditions in eight typical Minneapolis classrooms, the Twin City Section, School Lighting Committee, has presented a preliminary report to the Lighting Committee of the Minneapolis Board of Education. This report includes complete brightness distribution, footcandles and other physical data for the eight rooms which were selected as being typical of the 2,500 rooms in the Minneapolis schools. It also includes complete recommendations for relighting and making all necessary changes to provide a good visual environment in these rooms, including daylight controls, refinishing or replacing blackboards and desk tops, orientation of seating, and complete redecorating.

This project, which is being carried on jointly with the Minneapolis Board of Education Committee, was inaugurated over a year ago following a survey which showed the serious conditions which existed in the classrooms in Minneapolis. The installation of the new lighting equipment will be financed by the Northern States Power Company and the other physical changes carried out by the Board of Education when this project gets under way. The studies by the Twin City Section, School Lighting Committee will then be continued to completely analyze the new conditions for comparison with those found originally.

Members of the I.E.S. Committee include: Messrs. G. W. Frederick, G.

M. Felland, P. J. Murray, James Lang, N. K. Gullick, J. O. Kvalsten, S. F. McGowan, B. R. Bunn, T. E. Roche, W. T. Meloche; Professor E. W. Johnson, Dr. R. R. Tracht, and Mr. L. B. Paist.

Joint Meeting with Electrical Contractors

Another I.E.S. meeting of note was held by the Chicago Section recently, sponsored jointly with the Electrical Contractors of the Chicago Metropolitan area. A discussion on the "Electrical Contractor's Opportunity in Planned Lighting Progress" was presented.

The panel discussion was conducted by the Editorial Staff of the McGraw-Hill publication *Electric Construction and Maintenance* featuring William T. Stuart, Chief Editor; Berlon Cooper, Eastern Editor; and August Eckel, Middle West Editor.

The meeting was held Friday, December 10, 1948, at the Assembly Hall, 140 So. Dearborn Street, Chicago, Illinois.

Extension Conference for Florida Chapter

Although a number of Sections and Chapters of I.E.S. feature extension meetings in adjacent and distant cities, few surpass the conference-type meeting held in Miami recently by the Florida Chapter.

Organized by A. C. Bergh of Miami, the meeting attracted some 100 conferees from the full length of Florida, rated special welcome by the Coral Gables Chamber of Commerce and full coverage by the press.

Presiding officer for the dinner conference was James A. Banton, Chairman of the Florida Chapter, Tampa. Featured speaker was J. P. Rutherford, of the General Electric Illuminating Laboratories, Lynn, Mass., who discussed "Sports and Recreational Lighting for Night Time Play."

Unique Stage Show on Story of Lighting

Industry and the stage have joined forces to present a dramatic production "Look to Light," that tells in novel fashion the story of lighting in the past, present and future. Produced by the Lighting and Lamp Division of the Westinghouse Electric Corp., the 90-minute show is played by a professional cast and is on coast-to-coast tour which will include 33 major cities.

This presentation consists of six acts which dramatize the story of lighting methods in offices and stores, schools, factories, on streets, playgrounds and at airports. It marks one of the first efforts by industry to bring its story of science and engineering to the public by means of stage drama.

Narrator and veteran actor Noel Leslie, who has played more than 400 roles in 38 years on the stage, begins the show with an explanation and visual presentation of the sun's spectrum—source of all natural light and color. He goes on from there to weld together the dramatic scenes which emphasize what man's modern lighting techniques can accomplish.

While revealing the latest marvels of man-made lighting, the show also points up many amazing deficiencies and calls for corrective action. In the schoolroom scenes, for example, the clock is turned back 100 years to depict the schoolroom of that period in which the young scholar—played by charming 12-year-old Joyce Kane—is trying to study by the light of five candles. The dunce cap is the result of her efforts. And yet, as the show points out, an average of five foot-candles is the level of lighting in the usual schoolroom today.

A change of scene then shows the equally poor results produced by the over-lighted schoolroom where glare results in headaches and bad tempers for student and teacher alike. The final scene in this act reveals a correctly lighted room and the story ends happily as any lighting engineer could have predicted it would.

One of the most forceful sketches in the show is the factory drama. The plant superintendent whose requests for better factory lighting have been turned down finds himself confronted first with ineffective production and then with an injury to one of his veteran workmen. Threatening to resign, he brings the matter to a head and succeeds in getting top management to install modern factory lighting.

Other scenes in "Look to Light" include the crime and accident stories which spring from poor street lighting and show how the latest equipment and techniques provide effective remedies; the story of how lighting science is making aviation safer and more dependable by the development of lights that penetrate fog, direct air traffic and mark out landing runways.

The skit touching on juvenile delinquency dramatizes how today's sport and floodlighting provides healthful recreation for youngsters and keeps them off the streets. A captivating performer in this act is 8-year-old Carle R. Robbins, Jr., son of the show's director.

Not the least of the show's attractions are the unusual and effective stage sets and lighting effects. The final act depicts the forced landing of an airplane which sought in vain for an airport. The remarkable effect is accomplished in absolute darkness aided by voice and sound. The audience first sees the tiny lights of the plane in the distance. The lights come directly toward them and the lights grow larger as the plane approaches. As the plane lands it seems to come directly into the audience.

Immediately the next scene flashes into view and the audience sees how two different airports appear from the pilot's viewpoint when all the various marker lights and other illumination is on.

The production effects were accomplished by Dramaturgy Inc., of Cleveland, O., which produced the show in cooperation with Westinghouse scientists and engineers. The actors are: Noel Leslie, narrator, Leslie Mack, Hazel Kempf, David Jordan, Carl Santa, and the two child stars, Joyce Kane and Carle Robbins, Jr. All are veterans as actors on the stage, on the radio, and in the movies.

New Impetus to Planned Lighting Program

The Industrial and Commercial Lighting Equipment Section of NEMA, at its annual meeting in Cleveland on November 29, inaugurated a new program for planned lighting promotion. This activity, in the hands of the Promotion Committee, of which Mr. S. B. Williams, Manager of Customer Relations, Lighting Division, Sylvania Electric Products, Inc., is Chairman, will be started first in a single test city. Activity there is expected to demonstrate what can be done to make planned lighting an effective program for the whole industry.

In the test city selected, a market survey will be conducted to find out the potential for lighting business, methods by which lighting has been sold, by whom, the efficiency of lighting sales activities, customer desires,

I.E.S. Section and Chapter

Some of the men who are directing the activities of I.E.S. Sections and Chap-

Theodore C. Lauck
Alamo Chapter

A. E. Simpson
British Columbia Chapter

C. S. Woodside
Capital Section

T. S. Harmon
Central New York Chapter

Glenn G. Boyd
Chicago Section

William H. Kahler
Cleveland Section

Kenneth E. Estler
Connecticut Chapter

George C. Mittauer
Cornhusker Chapter

Mitchell J. Davis
Eastern Pennsylvania Chapter

J. A. Banton
Florida Chapter

Cecil L. Cannon
Georgia Section

F. M. Sholders
Heart of America Section

Ross M. Brown
Indiana Chapter

J. C. Gehan
Iowa Section

Loren R. Nall
Michigan Section

Joseph Thomas
Montreal Section

Chairman for Year 1949

ters this year. Photographs of the 10 other Chairmen were not available.

A. L. Perdue
Mother Lode Chapter

Henry J. Wilson
New England Section

Hutson Colcock
New Orleans Chapter

Miss Caroline E. Horn
New York Section

Samuel H. Hazelton, Jr.
Northern California Section

William J. Wilfert
Ohio Valley Section

Robert E. Lange
Oregon Section

Harry Restofski
Pittsburgh Section

K. E. Hollingsworth
Puget Sound Section

L. C. Twichell
Rochester Chapter

Lyle M. Bailey
Rocky Mountain Chapter

Henry Arendes
St. Louis Section

Leonard W. Towner
Southern California Section

H. Cecil Jones
Toronto Section

John O. Kvalsten
Twin City Section

J. Vernon Sharp
Utah Chapter

and what they do when they want to get new lighting. The program will be handled by a full-time director and coordinator, and will be carried on under the auspices of the local electrical league.

This program in the test city will coordinate the activity of all the local industry groups, and should produce the most effective sort of planned lighting promotion.

At frequent intervals during the program reports of the project will be made to the industry with the objective of stimulating similar local promotions in other cities.

In addition to this new effort of planned lighting, the Section will continue its Exposition activities in 1949. The Third International Lighting Exposition will be held at the Stevens Hotel in Chicago, opening on March 29. The Section will carry on its work on development of lighting standards, and its cooperation with other organizations such as the American Standards Association.

Organized in 1942 with 28 members, the Industrial and Commercial Lighting Equipment Section now has a membership of 63 of the most active manufacturers in the industrial and commercial lighting field. At the annual meeting, Mr. A. F. Wakefield, President, The F. W. Wakefield Brass Company, Vermilion, Ohio, was reelected Chairman of the Section for 1949.

Approach Lights to Aid Berlin Airlift

The construction of 42 of the world's brightest lights is being rushed for installation by the U. S. Air Force at German airports to help pilots flying the Berlin airlift in landing during bad weather visibility. A six-light system made by Westinghouse Electric Corp. will be installed at each of the seven different airports, including Berlin's Tempelhof Airdrome, to reduce the hazard of fog, snow, and rain and assist pilots in locating the field visually despite winter-time bad weather.

The first commercial installation of the new approach lights at New York's new International Airport on Long Island was described in detail in the paper by Kopf and Pennow at the I.E.S. National Technical Conference in Boston last September. A test installation of six lights—three krypton and three neon—has also been operating at the Cleveland Municipal Airport for more than a year and a half and has already been credited with saving lives. The six-light systems for the Airlift are intended as identification and lead-in lights for the standard approach systems. They will be installed in a row 1,000 feet long at 200-foot intervals out beyond the end of the instrument runways.

Nema Aviation Ground Lighting Section

The Aviation Ground Lighting Section of the National Electrical Manufacturers Association, taking over from its predecessor, the Airport Lighting Equipment Group of the Floodlighting Section, in January, 1948, has continued the close cooperation of the latter with the Lighting Division of the CAA Office of Airports in the development of CAA specifications for airport lighting fixtures and other components of airport lighting systems.

This activity has been carried on through the Section's General Engineering Committee, which has had as guests at its meetings representatives not only of the CAA Office of Airports, but of the Office of Federal Airways of the same agency, the United States Air Force, the Navy Bureau of Aeronautics, the Air Transport Association, and of glassware, lamp, and other interested manufacturers who are not members of the Section.

Specifications have been developed during the past year for obstruction lights, taxiway lights, cable connectors, individual lamp insulating transformers for 5,000-volt series circuits, airport cable, remote control panels, and brightness control assemblies. In addition, numerous amendments to the 18 CAA airport lighting specifications previously issued were recommended or reviewed.

The usual pratice has been for CAA to submit a preliminary draft of a new specification for the Committee's consideration. This draft is then discussed in detail at a meeting, and a final draft prepared by CAA on the basis of the recommendations and ideas so developed. In some cases, the Committee has taken the initiative in calling attention to the need for a specification and in developing data for inclusion in it.

A valuable result of this cooperative effort has been the coordination of CAA and Air Force specifications for similar items of equipment.

A meeting of particular interest was held during the summer at the Landing Aids Experiment Station, Arcata, California. This meeting was scheduled to follow a conference of CAA regional lighting engineers, and their attendance made possible a mutually helpful discussion of problems encountered in the field with airport lighting installations.

New Nema Floodlighting Standards

The Floodlighting Section of the National Electrical Manufacturers Association has concluded the most active and productive year in its history—a year marked by the approval of NEMA Standards for General-Purpose Enclosed Floodlights and Open-Type Porcelain-Enameled Floodlights, both in ratings from 300 to 1,500 watts and of recommended floodlight layouts for a wide variety of sports facilities, from Major League baseball fields to practice putting greens and shuffleboard courts.

The year also saw the inauguration of a promotional program designed to bring to the attention of those responsible for recreational activities in thousands of communities, schools and clubs throughout the country, the value of floodlighting in extending the hours of usefulness of outdoor recreational facilities of all sorts.

The first step in this program was participation by the Section in a full-color sound motion picture on community recreational planning, produced under the auspices of The Athletic Institute, an organization devoted to encouraging the development of community recreational programs and facilities. The Section was instrumental in having included in this picture extended night sports sequences.

The Section now has in preparation a sports floodlighting handbook, which will contain the recently approved standards and layouts. Several thousand copies of this handbook will be distributed by the Athletic Institute as a supplement to its manual on the planning of recreational facilities.

The new floodlight standards specify tests for weatherproof or weathertight construction and corrosion resistance, construction features, and performance in terms of beam efficiencies. They also provide a method of classification by type and group, the former referring to beam spread, while the "group" designation indicated enclosed or open-type, with further breakdown of enclosed units according to size, and of the open-type on the basis of whether or not they are equipped with auxiliary reflector inserts.

Iowa Section Holds Fall Conference

If the four conferences put on every year by the I.E.S. Iowa Section were added together, it would come to quite a meeting—probably of convention proportions. Their latest was the Fall Conference as a "one-day" meeting Friday afternoon and all evening on October 22, Mason City, Iowa.

Some 71 conferees heard the excellent program. Retiring Section Chairman L. C. Esthus presided at the conference; welcoming address was made by C. E. Strickland, President of the Peoples Gas and Electric Company, Mason City. Program of the conference included:

2:00 P.M. *Opening Session*

Meeting Called to Order, L. C. Esthus, chairman, Iowa Section

Welcome to Mason City, Charles E. Strickland, President, Peoples Gas & Electric Co., Mason City, Iowa

Introduction Conference Chairman, Ben. O. Horton, Crescent Electric Supply Co., Mason City, Iowa

2:15 P.M. "Application of Lighting Glassware" preceded by color sound film "Glass for Industry," C. W. Clarkson, Lighting Sales Engineer, Corning Glass Works, Chicago, Illinois

3:25 P.M. Recess

3:30 P.M. "Lighting as Applied to Architectural Design," W. D. Barnhizer, Manager Commercial Sales, Iowa Electric Light & Power Co., Cedar Rapids, Iowa

Discussion

4:30 P.M. "Latest Commercial Lighting Techniques." An illustrated talk on the newest Store, Resturant and Office Lighting including a discussion of Louverall, White Fluorescent Light Sources and Color, C. M. Cutler, Head Lighting for Selling Section, Engineering Division, Lamp Dept., General Electric Co., Cleveland, Ohio

Discussion

5:30 P.M. Summary of the Conference, L. C. Esthus, Chairman, Iowa Section

Review of 1947-48 Iowa Section Activities and Accomplishments

Introduction and Installation 1948-49 Officers and Board of Managers

Chairman, J. C. Gehan
Vice-Chairman, C. O. Christensen
Secretary-Treasurer, H. P. Wilson
Board of Managers, L. C. Esthus, J. H. Hull, C. P. Stone, J. C. Young, Jr.

Brief Reports Boston Conference, J. H. Hull, Des Moines, Iowa, and C. O. Christensen, Dubuque, Iowa

6:00 P.M. Sociability Hour

6:45 P.M. Dinner and Entertainment

New Lighting Center Opens

A new Lighting Center was opened in New York City recently, by the Sylvania Electric Products Inc. The unique "Before and After" theme of the Center demonstrates visually to the large crowds visiting it, how lighting may be used to transform a dingy 30-year-old house into an up-to-date home with a feeling of spaciousness and outdoor living. To visualize how an old house may be modernized, and to illustrate the contrast between old and new, an authentic reproduction of a typical suburban living room built 25 to 30 years ago has been constructed at the Center. Oak-framed doors leading to a porch flank a nondescript brick fireplace to make up one side of the room, and an oak-framed opening in the side wall leads to a connecting dining room.

Alongside this poorly lighted room in the same area, the Lighting Center has built a reproduction of the same room, remodeled, redecorated, and lighted according to modern standards. The contrast very dramatically demonstrates the role of lighting in the decoration and modernization of a home. Incorporating some twenty ideas for using light to best advantage in the home, the demonstration rooms illustrate how both fluorescent and incandescent lighting can be used decoratively to illuminate a wide variety of seeing tasks.

In addition to the modernized house which makes up the major exhibit in the remodeled Sylvania Lighting Center, there are four alcoves which suggest effective illumination for areas where good lighting is particularly important. Proposed solutions to lighting problems found in every home are featured, keyed to be within the reach of average incomes.

The new Lighting Center is located at 500 Fifth Ave., New York City.

RLM Institute Action on Reflection Factors

At the annual meeting of the RLM Standards Institute at the Hotel Statler in Cleveland, Ohio, last November 30, by unanimous vote, the members increased the reflection factor of all porcelain enamel reflectors used in incandescent and fluorescent units inspected and certified by the Institute.

The present reflection factor is 79%. This has been increased to 82%. The minimum acceptable reflection factor for any sample, which was 76½%, has been increased to 79%. The Institute also took action to de-

Typical 30-year-old suburban living room featured at the new Sylvania Lighting Center, New York. Adjacent to the room in the same lighting display area is shown how the same room may be transformed by modern lighting techniques.

Same area at the Sylvania Lighting Center showing modernized living room, and illustrating how fluorescent lighting combined with new trends in furnishings, can transform the interior of a conventional 30-year-old house into an up-to-date home.

velop new specifications for the new 96-inch fluorescent lamps.

During the next year, the Institute will continue its educational program of telling the story of the highest possible standards of performance and quality to the architects, consulting engineers, electrical contractors, lighting specialists and others throughout the country.

The following officers and trustees of the Institute were re-elected:

R. W. Staud—President
W. F. White—Treasurer
Leonard A. Hobbs—Secretary
D. J. Biller—Trustee
D. E. Worrell—Trustee
H. A. Barnes—Trustee

E.E.I. Offers Planned Lighting Awards

Prize awards with a total of $1,400 in cash, a bronze plaque and certificates of merit are offered to electric utility operating companies and their personnel for outstanding activities in the promotion of Planned Lighting during 1948, it has been announced by Edison Electric Institute and the Better Light Better Sight Bureau, joint sponsors of the awards.

A first prize of $200 and second prize of $100 will be awarded for the best promotional campaigns in each of the residential, commercial and industrial lighting markets. Certificates of merit will be given to the companies, with the cash prizes going to the personnel primarily responsible for the campaigns.

An engraved bronze plaque and $500 in cash will be awarded to the company with the best Planned Lighting program in all three markets combined.

The objective of the Planned Lighting awards is to give national recognition to utility operating companies that are most effective in raising the standard of lighting in their communities. The judges, it is announced, will give equal emphasis to educational programs on the relationship of light and sight, and to sales promotional activities designed to sell Planned Lighting in local markets.

Programs sponsored during the 12-month period ending Feb. 28, 1949, will be considered. Entries must be postmarked or received at EEI not later than midnight, April 15, 1949.

According to the terms of the awards, separate entries must be made for the residential and/or commercial and/or industrial Planned Lighting programs. Companies are free to choose, and may win a prize in one or more of these markets, in addition to the award for all three.

Among the factors to be considered by the judges are the educational activities in the principles of Better Light Better Sight, to include education of company personnel, consumers and allied industry elements; sales promotion and selling of Planned Lighting installations, including sales training and methods, Planned Lighting layout services, advertising and sales promotion, cooperative activities with contractors, dealers and others, and the quality and quantity of accomplishments.

The Planned Lighting Awards will be presented at the Annual Meeting of the Edison Electric Institute, in June, 1949.

New Journal on Southeastern Research

A new scientific journal covering engineering research progress in eleven Southeastern states will begin publication in January, 1949. Aimed at promotion of the engineering research profession in the Southeast, the new quarterly will carry technical papers, news reports, and editorial studies reflecting the rapid growth of research activity in the states lying from Virginia to Texas.

The new *Journal of Southeastern Research*, to be published by the Southeastern Research Institute of Atlanta, will report the activities and accomplishments of Southeastern laboratories and serve as a "conference table" for research leaders.

IT SEEMS TO ME

The Question of Illumination Intensities

To the Editor:

It seems to me that in the controversy over recommended intensities of illumination some important factors are being overlooked. No lighting engineer wishes to detract from the value of laboratory investigations as they play essential parts in the establishing of a scientific basis of our work. On the other hand it must be admitted that the attitude of a subject in an investigation to the task is different to that of an employee to the conditions of his job. The very fact that a person becomes a subject in an investigation would probably act as a stimulant that would lead to unintentionally greater effort to overcome visual difficulties than would some change in the conditions confronting a worker. Dr. Bitterman has given proof of the power of suggestion. University students who frequently act as subjects are young and their eyes can readily adapt themselves to a wide range of conditions. They and their visual tasks during an investigation can hardly be considered as typical of a worker at a job upon which his (or her) living depends. It therefore seems illogical to condemn established practice upon laboratory investigations alone.

In appraising the adequacy of illumination intensity considerable stress has been placed by the critics upon visual acuity, but from the viewpoint of performance this is a momentary function of the eyes not involving time beyond that required for its measurement. Ferree and Rand have shown (*Transactions* I.E.S. 1929) that there is a greater gain in performance resulting from increased intensity of illumination for those functions of the eyes that involve sustained effort. For example, the gain in acuity is least of all the functions. The gain is progressively greater for speed of adjustment, speed of discrimination and power to sustain clear seeing. The graph for the latter is almost a straight line up to 36 ft-c, the limit of the test. The level of diminishing returns is thus above 36 ft-c. This proves that the requirements for visual acuity do not satisfy the demands for sustained visual work. Dr. Bitterman frankly states, ILLUMINATING ENGINEERING, September 1948, page 910, that "continued work seemed to take a toll of the organism and initial levels of performance can be maintained only at the expense of greater exertion than before." There is no dearth of proof of this fact.

Dr. Ferree has stated that nature demands perfect vision and the eyes will automatically strain themselves to achieve it when necessary. Further, that eyes that are slightly defective cause more headaches than those

with more pronounced defects because by making extra effort slight defects may be overcome but the extra effort is conducive to headaches. Nature recognizes inability to overcome greater defects, and no effort is made. Such factors as these are not taken into account when basing lighting recommendations upon initial performance.

Dr. Bitterman's analogy of visual efficiency to automobile efficiency, ILLUMINATING ENGINEERING, September 1948, page 908, does not apply to the point that he tries to prove. Decreasing the difficulty of performing any task will naturally result in either more work for the same energy as before or less energy for the same work. A car traveling over smooth, level roads will use less energy or travel farther than when going over rough, sandy or hilly roads. Who will deny that better lighting eases the tasks of the eyes?

Experience has shown that first impressions, after changes in lighting, are not always reliable. Workers have been known to react (sometimes strenuously) against what was known to be an improvement because some slight change in their visual habits was required. It is only after the newness of the altered conditions has worn off that the actual results may be looked for. This suggests that caution should be used in appraising the results of short-time tests.

The critics of present intensity recommendations apparently base their criticisms upon laboratory tests involving short periods of time and generally young subjects. A very substantial percentage of workers are of middle age. Furthermore, there is a large percentage with defective eyes. Investigators, Luckiesh and Moss and Feree and Rand, have shown that these two groups require much more illumination than those with normal sight and that these groups derive the greatest benefit from improvements in illumination. Furthermore, there is a wide gap between the laboratory and the work-world. It seems apparent that the critics have had less direct contact with workers at their daily tasks than those who have, by joint effort, established the existing standards for practice. Laboratory investigations are the beginning; actual use in the work-world is the end and it is the end result that determines whether lighting is sufficient or not, or good or bad.

GEORGE G. COUSINS
Fellow, I.E.S.

ABOUT PEOPLE

Stuart L. Bailey has been elected President of the Institute of Radio Engineers for 1949. He is a consulting radio engineer and partner of the firm, Jansky and Bailey, Washington, D. C.

Arthur S. McDonald, chief engineer of the Overseas Telecommunication Commission, Sydney, Australia, is the new IRE Vice-president.

Dr. J. A. Hutcheson, Director of the Westinghouse Research Laboratories, has received that company's Order of Merit "for his valuable engineering contributions to the development of radio broadcasting equipment, military radar and other electronic apparatus," and for "his capable management and direction of the Research Laboratories." This is the highest award of the Westinghouse Electric Corp. and is conferred by vote of the company's Board of Directors.

William F. Mattes, Jr. has been appointed chain store sales specialist for the New York Sales District of General Electric's Lamp Dept. Mr. Mattes has been with General Electric since 1926, most recently with the Lamp Dept. headquarters in Cleveland.

C. W. McCormick has been appointed Supervisor of Commercial Lighting to coordinate all electric commercial activities of The Connecticut Light and Power Co. Mr. McCormick served five years with the U.S. Corps of Engineers and became associated with Connecticut Light and Power shortly after his release from the Army in March, 1946. He is on the I.E.S. Connecticut Chapter Board of Managers and Chairman of their Program Committee.

A. C. Monteith, recently elected Vice-president in charge of Engineering and Research of the Westinghouse Electric Corp. (I.E., November 1948), has been awarded the honorary degree of Doctor of Laws by his alma mater, Queens University. The degree was conferred during graduation ceremonies for students who have completed summer studies in engineering.

W. V. O'Brien has been appointed General Sales Manager of General Electric's Apparatus Department in Schenectady. Mr. O'Brien has been associated with General Electric Co. since 1922, when he entered the company's "test course." He served in several sales engineering capacities, and since December, 1947 has been Assistant General Sales Manager. He will continue to direct the coordinated sales activity of the Apparatus Department's sixteen product divisions through Apparatus sales offices throughout the country.

Frank Paeske has been appointed Manager of Miniature Lamp Sales of Westinghouse Electric Corp., Bloomfield, N. J. Mr. Paeske will coordinate the activities of the eight district offices and headquarters in connection with sales of automotive lamps, flashlight lamps, Christmas tree lamps and other miniature types.

George Porter Paine has been appointed Director of Promotion of the American Standards Association. He will continue to act as Executive Assistant to Howard Coonley, Chairman of ASA's Executive Committee.

Edward H. Smith, formerly Western District Manager for Canadian Westinghouse Co., Ltd., has been named Special Representative in the Western District for that company. He is in his 40th year with Westinghouse.

Stanley M. Smith succeeds E. H. Smith. He has been with Canadian Westinghouse Co., Ltd., since 1913, the last thirty years as Branch Manager at Fort William.

Edwin D. Tillson, who recently retired as Supervisor of the Testing Dept. of the Commonwealth Edison Co., Chicago (I.E. September, 1948), has joined the staff of Lighting Products Inc., Highland Park, Ill. as consulting engineer. Mr. Tillson will work on new lighting equipment designs and lighting application problems.

Clarence C. Walker has been appointed General Manager of General Electric's Construction Materials Dept. in Bridgeport, Conn. Mr. Walker will be in charge of the development, manufacture and sale of wire and cable, wiring devices, accessory equipment and conduit products. He has been with General Electric since 1921 and has been Commercial Vice-president assigned to customer relations work in the New England area since December, 1947.

B. W. Clark, Vice-president in charge of sales for the Westinghouse Electric Corp., Pittsburgh, Pa., was elected President of the National Electrical

Manufacturers Association at the Association's 22nd Annual Meeting being held during the week of November 8 in Atlantic City. He succeeds W. C. Johnson, Vice-president of Allis-Chalmers Manufacturing Co. Newly-elected members of the Board of Governors are: **David J. Biller**, President of Day-Brite Lighting Inc., St. Louis, Mo.; **Raymond C. Cosgrove**, Executive Vice-president and a Director for Aveo Manufacturing Corp., Cincinnati, Ohio; **Roy E. Murphy**, Vice-president in charge of sales, I-T-E Circuit Breaker Co., Philadelphia, Pa., and **W. B. Clements**, Vice-president and Sales Manager of the Master Electric Co., Dayton, Ohio.

BOOKS AND PAMPHLETS

An Introduction to Color, a new book by Ralph M. Evans (John Wiley & Sons, New York City, and Chapman & Hall, Ltd., London; 1948) has a special timeliness for the lighting man, in whose activities color is coming to play a rapidly expanding role. Seldom does the literature produce so comprehensive a treatment of a complex subject in a style so readable. Mathematics are avoided in deference to the lay reader, yet the thoroughgoing scientific approach and the profusion of superior illustrations will appeal to the expert as well.

Although not particularly written from the viewpoint of the illumination engineer, the broad treatment of the subject in terms of its "physical, psychophysical and psychological aspects," provides valuable correlations for the lighting specialist as well as the artist, the architect, and the color technician.

The scope of the book is well indicated by the chapter titles.

1. Color and Light
2. The Physical Nature of Light
3. Light Sources
4. Illumination
5. Colored Objects
6. The Physics of Everyday Color
7. Color Vision
8. The Visual Variables of Color
9. Perception and Illusion
10. Brightness Perception
11. Color Perception
12. The Measurement of Color
13. The Specification of Color
14. Color Differences and Color Names
15. Mixtures of Colored Lights
16. Effects of Illuminants
17. Transparent Colorant Mixtures
18. Paints and Pigments
19. Color in Photography
20. Color in Art
21. Design and Abstraction

The chapters on Perception and Illusion, Color in Photography, and Colored Objects are particularly well developed and illustrated, and the chapter on Effects of Illuminants is very timely, although it deals largely with theoretical sources rather than actual ones.

The author includes no references to the literature of the Illuminating Engineering Society in his bibliographies. His material has therefore not been specifically related to much of current lighting problems. For example, the chapter on Mixtures of Colored Lights makes no mention of the useful fluorescent lamp color mixing nomogram, nor does the chapter on Effects of Illuminants discuss the light source in relation to textile color matching. Nevertheless, the lighting man will find this work will make a highly appreciated contribution to his understanding of the many-sided subject of color.

The book is priced at $6.00 per copy.

The Techniques of Stage Lighting, by Gillespie Williams, a book just released by Pitman Publishing Co., is a very practical contribution to the subject, from four different viewpoints. For the several different types of readers most likely to use such a text—stage producer, lighting expert, artist, engineer or contractor—the book has been divided into four parts for ready reference.

Part I—Scientific Basis—gives important information concerning vision, color and the science of illumination, knowledge of importance to any one concerned with the *use* of stage lighting.

The architect, engineer and contractor engaged in the design and layout of stage lighting may be primarily interested in Part II—The Adaptation and Control of Light—which includes five chapters dealing with stage lighting and control apparatus, together with its layout and installation.

Part III—The Art of Stage Lighting—outlines principles for the effective use of light and color in building up artistic lighting compositions. While it is hard to lay out rules concerning artistic matters, the author has based his information on his own researches and experience.

Part IV—Practical Lighting for Stage Production— has the amateur enthusiast in mind, with the thought, nevertheless, that professional producers will find the section of major interest.

The Techniques of Stage Lighting is published in England, but is available also here. In the U. S. the book is $6.00, from Pitman Publishing Corp., 2 West 45th St., New York 19, N. Y. In England it is 21 shillings net from Sir Isaac Pitman & Sons, Ltd., London.

The Specifications and Law on Engineering Works, by Walter C. Sadler, is designed as a practical aid for the engineer not trained in law. In addition to the complete description of the engineer's commonly encountered legal problems, a summary of the historical significance of various legal systems is also included to show how modern courts apply statutes to practical legal questions on engineering works. Among the topics specifically discussed with examples taken from actual experience are the legal instruments of contractual documents, illegal matters of concern to engineers, the law on agency partnerships and corporations, patents and workmen's compensation. A complete set of detailed contracts and specifications, covering the construction of a transmitter building for the University of Michigan, is presented in the appendix.

The author is currently Professor of Civil Engineering at Michigan, and has had an outstanding record in engineering, law and teaching.

Specifications and Law on Engineering Works is published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 17, N. Y., and is available for $5.00.

Several new Planned Lighting promotional aids have recently been prepared by the Edison Electric Institute and the Better Light Better Sight Bureau, joint sponsors of the Planned Lighting Program. Recent releases include:

Lighting Ideas to Brighten Your Home, a booklet presenting many practical, inexpensive ideas for modernizing home lighting. This is a two-color, 12-page booklet aimed particularly at medium- and low-income customers. It is packed with low cost ideas for use in improving the present home lighting and bringing illumination levels up to modern standards. Illustrations and text show how to eliminate glare and shadows, and cover the best use of adapters, pin-to-wall and portable lamps, and packaged valances. A check list of recommended lamp bulb and shade sizes, suggestions for proper placement of lamps and many other subjects are presented in simple, non-technical style. The booklet is intended as a mailing piece and in answer to requests for information on home lighting. Available from Edison Electric Institute, 420 Lexington Ave., New York, N. Y.

A folder to show why children's study areas in the home should have better light in offered in *How to Make Homework Lighter*. It is intended to inform parents, teachers and students of the latest lighting recommendations for study and homework, and to encourage improvement of the seeing facilities now provided for too many children. Through effective use of before and after photographs, it shows the difference in seeing conditions that can be accomplished through proper selection and placement of lamps, avoidance of glare and other factors. This folder can be used as a mailing piece, for distribution at PTA and other group meetings, and by home lighting advisors in their customer contacts. Available from Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y.

Planning Your Sunshine Home with Lighting, for Better Lighting, a folder designed especially to give lighting advice to prospective home builders or modernizers, explains why their lighting and wiring needs deserve first consideration. A compact list of home lighting suggestions is presented, with brief copy covering the lighting recommendations for every room in the average home, and urging builders to provide for adequate lighting and wiring while homes are still in the planning stage. Available from Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y.

Three other mailing pieces are offered by E.E.I., promoting the benefits of planned lighting as an effective aid in food stores. Aimed directly at the electric company's largest commercial lighting market, these mailers are expected to produce many requests for the planned lighting service offered by utilities, contractors and others.

Samples of the foregoing booklets are available upon request to Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y.

The Westinghouse Electric Corp. has recently announced a new 50-page booklet, giving complete information on large airport lighting and distribution. Detailed lighting plans and wiring diagrams for typical airports are included in the book to assist airport executives in planning a new field or improving an old one. Other sections cover lighting and distribution equipment. The equipment is keyed by symbols to the lighting and wiring diagrams and a simple runway equipment chart facilitates selection. A part of the booklet is devoted to associated airport equipment that covers everything from wind instruments to engine starters. A special section discusses the new all-weather approach lighting systems, a landing aid visible through 1,000 feet of the thickest fog. A copy of the booklet may be obtained from the Westinghouse Electric Corp., P. O. Box 868, Pittsburgh, Pa.

The series of studies on "The Duration and Intensity of Sunshine" by Frank Benford, being published at intervals in ILLUMINATING ENGINEERING, has resulted in communication from the Department of Works and Housing of the Australian Government, and a complimentary copy of their booklet on similar studies. Although they have approached the subject from a slightly different viewpoint, their published document will be of interest to all concerned with such fundamental data. The booklet is identified as Duplicated Document No. 23, "Sunshine and Shade in Australia." A protractor and charts are included to provide a simple means of solving many of the problems involved in the study. The document is available from the Department of Works and Housing, Commonwealth Experimental Building, P. O. Box 30, Chatsworth, N.S.W., Australia.

A new booklet entitled "Photo Lamp Data," containing 12 pages of information on photographic lamps and their applications, has been announced by General Electric Co., Nela Park, Cleveland, Ohio. Designed as a guide for professional and amateur photographers, the booklet features a discussion of the triangle lighting formula recently introduced, telling exactly where and how to place two or more lamps for best results. In addition, the pamphlet contains a special section on proper exposure times with all types of flash and flood lamps to ensure accurate results in black and white, color, stills and movies; manufacturers' recommendations on the use of filters, especially for color photography, with flash and flood lighting; complete data on the characteristics and uses of the photoflash lamp line; data on types, characteristics and uses of equipment essential to good photoflood photography; information on flashtunes, enlarger lamps, darkroom lamps, and others. The illustrated booklet also contains numerous tables giving information from which the photographer may draw for approved practice. Special tips are given for "a better lighted picture, even in the sun," and for "a better lighting picture on still or movie screen." The Photo Lamp Data booklet is available through photographic dealers.

An RLM Specification booklet has recently been released designed to acquaint all who are interested in the purchase, specification or installation of industrial lighting equipment, with the importance of the quality standards established by the RLM Institute. The booklet "Standard Specifications for Industrial Lighting Units" is available without charge from the RLM Standards Institute, Publications Office, 326 West Madison St., Chicago 6, Ill.

Obituary

At the meeting of Council held December 8, 1948, the deaths of one Member and three Associate Members of I.E.S. were regretfully reported.

Paul N. Young, a member of I.E.S. for 23 years, died recently at Greenville, Ohio. Mr. Young was currently serving the Society as Local Representative in Greenville. A graduate of Michigan University where he studied under the late Professor H. H. Higbie, Mr. Young saw service in both World Wars. Since 1937 to the time of his death, Mr. Young was associated with the Greenville Electric Light and Power Co., Greenville, Ohio. He was 53 years of age.

Arthur S. Detsch, an Associate Member of I.E.S., Oregon Section, has been reported deceased. Mr. Detsch was a District Manager for the Sylvania Electric Products, Inc., Portland, Oregon until 1943 when he formed his own company.

W. T. Foley, Associate Member since 1941, died recently in Kansas City. Mr. Foley, an active member of the Heart of America Section, headed the W. T. Foley Electric Company of Kansas City, and was long interested in lighting in that city.

Edward V. Conroy, a fairly recent election to I.E.S. membership, died this past month in San Francisco, California. A prominent electrical contractor on the coast, Mr. Conroy was a partner in the electrical contracting firm of Weber and Conroy, San Francisco. Mr. Conroy was 46 years old.

NEW MEMBERS

At the meeting of Council Executive Committee held in Cleveland, Ohio on November 18, 1948, the following were elected to membership.

BALTIMORE CHAPTER

Associate Members: Harold Dermer, Robert B. Preston, Jr.

BRITISH COLUMBIA CHAPTER
Associate Members: Gilbert Kelso, Christopher McGregor.

CHICAGO SECTION
Members Emeritus: J. L. Stair, E. D. Tillson.
Associate Members: A. A. Anderson, Stephen Furbacher, Jerry M. Kroot.
Student Members: Albert M. Bacalar, William R. Birkey, William L. Frank, Marshal L. Froland, Joseph G. Platt, George Spiegel, William Henry Tometich, Robert Louis Whitworth.

CLEVELAND SECTION
Members: Robert I. Bull, Wentworth M. Potter.
Associate Members: W. H. McFadden, Robert E. Faucett, Arthur D. Harrington, Harold Wesley Howard, M. F. Kriehbaum, Matthew J. Vitartas, Jr., C. E. Wagenman.
Student Members: Russell de Ward Churchill, Stuart I. Mendelson, Joel E. Rubin.

CONNECTICUT CHAPTER
Associate Members: Stanley Howard Levine, Robert A. Morris, Michael R. Sugrue.

DOMESTIC NON-SECTION
Members: James O. Spear, Gordon Wells.
Associate Member: Ernest C. Cain, Jr.
Student Members: Robert M. Aden, Joseph M. Harvey, Allen R. LeMaster, W. L. Morris, Jimmie Lee Ogresby, Robert L. Shuler, Harold Peyton Sudduth, John Sharp Williams, IV.

EASTERN PENNSYLVANIA CHAPTER
Associate Member: A. J. Arasini.

FLORIDA CHAPTER
Member: Leslie J. Klotz, Jr.
Associate Members: Clinton V. Brown, H. B. Connell, Thomas F. Hurst.

GEORGIA SECTION
Member: Herbert L. Reed.

HAMILTON, ONTARIO CHAPTER
Associate Members: D. H. Hymers, P. M. Sandham, Albert Teather.

HEART OF AMERICA SECTION
Member: Jesse C. Hicks.

IOWA SECTION
Associate Members: Louis H. Hahn, J. E. Hiatt.

MICHIGAN SECTION
Associate Members: Benjamin F. Avery, William T. McNaughton, R. B. Tuchan, Melvin J. De Young.
Student Member: Wilford Arthur Goll.

MILWAUKEE CHAPTER
Member: Walter MacCue.
Associate Member: William Marshall.

NEW ENGLAND SECTION
Associate Member: K. H. Bohaker.

NEW ORLEANS CHAPTER
Members: Hutson Colcock, R. C. Paslay.
Associate Members: E. Judson Demarest, Emmett H. Fremaux, Warren G. Moses.

NEW YORK SECTION
Member Emeritus: Willis R. Whitney.
Members: Ludwig Keonig, Warren R. Walker.
Associate Members: George L. Estler, Joseph W. Fleming, Irving Gerber, Alfred E. Martin, Henry J. Wald, Richard F. Townsend.

OHIO VALLEY SECTION
Member: Stella M. Fetzer.
Associate Members: J. H. Lord, G. A. Weatherton, C. B. Talley.
Student Members: Ronald L. Campbell, Richard J. Kuenzel.

OREGON SECTION
Associate Members: Kenneth P. Hill, William F. Mason.

PHILADELPHIA SECTION
Associate Member: W. H. Kemper.

PITTSBURGH SECTION
Member: Donald S. Jones.

SOUTH TEXAS CHAPTER
Associate Members: Thomas L. Moore, J. M. Payne.

SOUTHWESTERN SECTION
Member: W. E. Gresham.
Associate Members: Irwin E. Elkins, William N. Ray, John E. Sisson.

TORONTO SECTION
Associate Members: K. D. Ainsworth, J. H. Gilbreath, George H. MacDonald, H. Smith, R. W. Kington.

UTAH CHAPTER
Associate Member: Marvin E. Dansie.

WESTERN NEW YORK SECTION
Member: Paul E. Bowers.

The Lighting Calendar

Society Events

February 9, 1949 — Meeting of I.E.S. Council, 51 Madison Avenue, New York, N. Y.

February 10, 1949 — Meeting of I.E.S. National Nominating Committee, 51 Madison Avenue, New York, N. Y.

March 3-4, 1949 — South Pacific Regional Conference, San Francisco, Calif.

March 10-11, 1949 — Pacific Northwest Regional Conference, Portland, Ore.

April 3-5, 1949 — Southwestern Regional Conference, Houston, Texas

April 7, 1949 — Meeting of I.E.S. Council, Edgewater Beach Hotel, Chicago, Ill.

April 28-29, 1949 — Canadian Regional Conference, Toronto, Canada

May 13-14, 1949 — Northeastern Regional Conference, Hartford, Conn.

May 23-24, 1949—Great Lakes Regional Conference, Rochester, N. Y.

June 2-3, 1949 — East Central Regional Conference, Harrisburg, Pa.

June 8, 1949 — Meeting of I.E.S. Council, 51 Madison Ave., New York, N. Y.

September 19-23, 1949 — National Technical Conference, French Lick Hotel, French Lick, Ind.

Industry Events

January 3-15, 1949 — Chicago Lamp Show, Chicago, Ill.

January 10-14, 1949 — New York Lamp Show, Hotel New Yorker, New York, N. Y.

January 15, 1949 — Independent Electrical Contractors Ass'n, Inc., 43rd Annual Dinner, Hotel Astor, New York, N. Y.

January 17, 1949 — American Institute of Consulting Engineers, Dinner and Annual Meeting, New York, N. Y.

January 24, 1949 — 55th Annual Meeting, American Society of Heating and Ventilating Engineers, Stevens Hotel, Chicago, Ill.

January 24-27, 1949 — American Gas Association Home Service Workshop, Hotel Statler, Cleveland, Ohio

Jan. 31 - Feb. 4, 1949 — American Institute of Electrical Engineers, Winter General Meeting, Hotel Pennsylvania, New York, N. Y.

February 11, 1949 — Annual National Observance of the Birth of Thomas Edison, Milan, Ohio

February 11, 1949 — Edison Pioneers, 32nd Annual Luncheon and 31st Annual Meeting. Location to be announced.

March 8-11, 1949 — Essex Electrical League, Fifth Electrical Exposition, Mosque Theatre Bldg., Newark, N. J.

March 9, 1949 — Inter-Society Color Council, 17th Annual Meeting, Hotel Pennsylvania, New York, N. Y.

March 10-12, 1949 — Optical Society of America, Annual Meeting, Hotel Pennsylvania, New York, N. Y.

March 13-18, 1949 — National Electrical Manufacturers Ass'n, Winter Convention, Edgewater Beach Hotel, Chicago, Ill.

Week of March 28, 1949 — Third International Lighting Exposition and Conference, Hotel Stevens, Chicago, Ill.

Mar. 29 - Apr. 1, 1949 — 19th Annual Safety Convention and Exposition, Hotel Pennsylvania, New York, N. Y.

April 4-6, 1949 — American Gas Association, Distribution, Motor Vehicle, and Corrosion Conference, Netherland Plaza Hotel, Cincinnati, Ohio

April 5-7, 1949 — A.G.A. Sales Conference on Industrial and Commercial Gas, Andrew Jackson Hotel, Nashville, Tenn.

April 11-13, 1949 — A.G.A.-E.E.I. Spring Accounting Conference, Hotel Book-Cadillac, Detroit, Mich.

May 1-6, 1949 — National Electrical Wholesalers Association, 41st Annual Convention, Netherland Plaza Hotel, Cincinnati, Ohio

May 7, 1949 — Eastern Electrical Wholesalers Association, Dinner and Dance, Hotel Astor, New York, N. Y.

May 16-19, 1949 — National Fire Protection Association, 53rd Annual Meeting, Fairmont Hotel, San Francisco, Calif.

June 20-24, 1949 — American Institute of Electrical Engineers, Summer General Meeting, New Ocean House, Swampscott, Mass.

June 21-23, 1949 — American Society of Heating and Ventilating Engineers, Semi-Annual Meeting, Minneapolis, Minn.

July 2-9, 1949 — New York State Association of Electrical Contractors & Dealers, Inc., Golden Anniversary Convention, Saranac Inn, N. Y.

October 17-20, 1949 — American Gas Association, Annual Convention, Chicago, Ill.

Oct. 31 - Nov. 4, 1949 — 37th National Safety Congress, Chicago, Ill.

LOCAL MEETINGS

CANADIAN REGION

Hamilton, Ontario, Chapter Meetings

Date: May 17, 1948.
Place: Royal Connaught Hotel, Hamilton.
Presiding Officer: M. M. Cockburn, Provisional Chairman.
Subject: Election of officers and presentation of Charter.
Attendance: 35.
Remarks: Dinner meeting.

Date: October 5, 1948.
Place: Fischer's Hotel, Hamilton.
Presiding Officer: Walter P. Bennie, Chairman.
Subject: "Power Conservation," by M. J. McHenry, Director of Consumer's Service, Hydro Electric Power Commission, Ontario; film on recent Hydro Developments.
Attendance: 30.
Remarks: Joint dinner and regular meeting.

Montreal Section Meeting

Date: October 27, 1948.
Place: Engineering Institute of Canada Building.
Presiding Officer: J. Thomas, Chairman.
Subject: "Cold Cathode Lighting," by Robert R. Wylie, Supervisor of Fixture Section, Commercial Engineering, Sylvania Electric Products, Ipswich, Mass.
Attendance: 94.
Remarks: Dinner meeting.

Ottawa Chapter Meetings

Date: October 13, 1948.
Place: National Research Council Auditorium, Ottawa.
Presiding Officer: E. G. Morrison, Chairman, National Research Science Association.
Subject: "Colour," by Norman F. Barnes, General Electric Co., Schenectady, N. Y.
Attendance: 300.
Remarks: Joint meeting with the National Research Science Association of Ottawa.

Date: November 10, 1948.
Place: Ottawa Technical High School.
Presiding Officer: D. S. Robertson, Chairman.
Subject: "Lighting of Public Buildings" by E. Rambusch, Rambusch Decorating Co., New York City.
Attendance: 25.

Toronto Section Meetings

Date: October 4, 1948.
Place: Mining Building, University of Toronto.
Presiding Officer: H. C. Jones, Chairman.
Subject: "Hydro Conservation Resources and Developments," by M. J. McHenry, Director of Consumers Services, Hydro Electric Power Commission of Ontario.
Attendance: 60.
Remarks: Dinner meeting with entertainment before technical session.

Date: October 25, 1948.
Place: Mining Building, University of Toronto.
Presiding Officer: H. C. Jones, Chairman.
Subject: Forum: "What Lamps to Use."
Master of Ceremonies — Bruce McCall.
"Incandescent Lamp," by W. Hardman, Service Lamp Co.
"Hot and Cold Fluorescent Lamps," by J. W. Bateman, Canadian General Electric Co.
"Mercury and Sodium Vapour Lamps," by G. F. Mudgett, Canadian Westinghouse Co.
Attendance: 70.
Remarks: Dinner meeting with entertainment preceding technical session.

EAST CENTRAL REGION

Capital Section Meeting

Date: October 6, 1948.
Place: Statler Hotel, Washington, D. C.
Presiding Officer: C. S. Woodside, Chairman.
Subject: (1) "Sources for Projection Equipment," by John A. Bartelt, Engineer Research and Development Laboratories, Fort Belvoir.
(2) "Modulated Light Sources," by Prof. W. S. Huxford, Northwestern University.
(3) "Atmospheric Transmissometry," by C. A. Douglas, National Bureau of Standards.
(4) "Lamp Progress and Development in 1948," by Alston Rodgers, General Electric Co., Nela Park, Cleveland, Ohio.
Attendance: 75.
Remarks: Joint morning meeting with A.I.E.E.

Philadelphia Section Meetings

Date: September 14, 1948.
Place: Longwood Gardens, Dupont Estate, Kennett Square, Penna.
Presiding Officer: Leroy Winters, Chairman.
George E. Shoemaker, Incoming Chairman.
Subject: Inspection trip of illuminated gardens and fountains.
Remarks: Joint meeting with Wilmington Lighting Club, with comments by Leroy Winters, outgoing Chairman, George E. Shoemaker, incoming Chairman, and the President of the Wilmington Lighting Club.
Attendance: 518.

Date: October 18, 1948.
Place: Edison Building.
Presiding Officer: George E. Shoemaker, Chairman.
Subject: "What Is New in Lighting," the report of the I.E.S. Prog-

ress Committee by Samuel G. Hibben, Director of Applied Lighting, Lamp Division, Westinghouse Electric & Manufacturing Co.
Attendance: 85.
Remarks: Joint meeting with the Philadelphia Foremen's Club.

Date: November 9, 1948.
Place: Electrical Association of Philadelphia.
Presiding Officer: George E. Shoemaker, Chairman.
Subject: "Office Lighting," panel discussion by Willard E. Fichthorn, Consulting Engineer, Philadelphia, Roy Barner, Building Manager, Howard Miller, Electrical Contractor, R. H. Adair, Westinghouse Electric Corp., P. B. Thorne, General Electric Co.
Attendance: 145.
Remarks: Joint meeting with the Building Owners and Managers Association, Philadelphia. Preceding this meeting, there was an I.E.S. meeting on Home Lighting, held at 4:00 p.m. at the Philadelphia Electric Co. Auditorium. Subject—"Four Degrees of Home Lighting" by Myrtle Fahsbender, Director of Residential Lighting, Westinghouse Electric Corp., Bloomfield, N. J.
Attendance: 30.

Pittsburgh Section Meeting

Date: October 18, 1948.
Place: Roosevelt Hotel.
Presiding Officer: Harry Restofski, Chairman.
Subject: "Fitting Footcandles to Visual Tasks," by Dr. Matthew Luckiesh, Director Lighting Research Laboratory, General Electric Co., Nela Park, Cleveland, Ohio.
Attendance: 195.
Remarks: Dinner meeting.

GREAT LAKES REGION

Central New York Chapter Meeting

Date: October 15, 1948.
Place: Crouse Hinds Company.
Presiding Officer: T. H. Harmon, Chairman.
Subject: "Airport Lighting," by John Haney, Crouse Hinds Co.
Attendance: 32.

Cleveland Section Meeting

Date: October 4, 1948.
Place: Television Studio WEWS.
Presiding Officer: W. H. Kahler, Chairman.
Subject: "Television Techniques," by J. Harrison Hartley, Director of Television, WEWS.
"Lighting for Television," by G. A. Coleman, Chief Studio Engineer, WEWS.
Attendance: 97.

Ohio Valley Section Meetings

Date: September 15, 1948.
Place: Terrace Plaza Hotel, Cincinnati.
Presiding Officer: Wm. J. Wilfert, Chairman.
Subject: Inspection tour of Terrace Plaza Hotel.
Attendance: 60.

Date: October 28, 1948.
Place: Cincinnati Gas & Electric Co.
Presiding Officer: Wm. J. Wilfert, Chairman.
Subject: "New Developments in Illumination," report of Progress Committee of I.E.S., by Samuel G. Hibben, Director of Applied Lighting, Westinghouse Electric Corp., Bloomfield, N. J.
Attendance: 250.
Remarks: Joint meeting with Cincinnati Chapter of A.I.E.E.

Michigan Section
Residence Lighting Forum of

Date: November 3, 1948.
Place: Detroit Edison Company.
Presiding Officer: Mary Taepke, Chairman.
Subject: "Lamps and Traditional Design," by Bruce Bradshaw, Interior Decorator.
Attendance: 25.

Rochester Chapter Meetings

Date: October 13, 1948.
Place: Hotel Rochester.
Presiding Officer: L. C. Twiel Chairman.
Subject: "Fitting Footcandles to Visual Tasks," by Dr. Matthew Luckiesh, Director Lighting Research Laboratory, General Electric Co., Nela Park, Cleveland, Ohio.
Attendance: 100.

Date: November 11, 1948.
Place: Normandie Hotel.
Presiding Officer: L. C. Twitchell, Chairman.
Subject: "Luminous Louverall Lighting," by Benjamin S. Benson, Jr., Benjamin Electric Manufacturing Co., Des Plaines, Ill.
Attendance: 43.

MIDWESTERN REGION

Chicago Section Meeting

Date: October 1, 1948.
Place: Chicago Lighting Institute.
Presiding Officer: Glenn G. Boyd, Chairman.
Subject: Inspection trip through the New Chicago Lighting Institute.
Attendance: 89.
Remarks: Study Club Meeting: Presiding Officer, R. R. Lusk, President; Subject, "Application of Lighting Glassware," by Clarence W. Clarkson, Corning Glass Works.

Iowa Section Meeting

Date: October 22, 1948.
Place: Hanford Hotel, Mason City.
Presiding Officer: L. C. Esthus, Chairman.
Subject: Fall Conference: "Application of Lighting Glassware" and color sound film, "Glass for Industry," by C. W. Clarkson, Lighting Sales Engineer, Corning Glass Works, Chicago, Ill. "Lighting as Applied to Architectural Design," by W. D. Barnhizer (Architect), Iowa Electric Light & Power Co., Cedar Rapids, Iowa. "Latest Commercial Lighting Techniques," with illustrations by C. M. Cutler, General Electric Co., Nela Park, Cleveland, Ohio. Reports on 1948 Technical Conference, Boston, 1948, by J. H. Hull, Des Moines, and C. O. Christensen, Dubuque.
Attendance: 71.
Remarks: Afternoon technical session, followed by installation of officers, dinner and entertainment.

Milwaukee Chapter Meetings

Date: September 30, 1948.
Place: Leader Electric Company, Chicago.
Presiding Officer: R. R. Knoerr, Chairman.
Subject: Inspection trip through Leader Electric Co.
Attendance: 55.
Remarks: Meeting preceded by attendance at ball game at Wrigley Field Ball Park, courtesy of Leader Electric Co.

Date: October 21, 1948.
Place: Milwaukee Engineers' Society Building.
Presiding Officer: R. R. Knoerr, Chairman.
Subject: "Highlights of the National Technical Conference at Boston," by I. L. Illing, Chas. N. Laupp, John Wanska, M. H. Bruesewitz, Wisconsin Electric Power Co.
Attendance: 64.
Remarks: Meeting followed by lunch and social hour.

Twin City Section Meeting

Date: October 18, 1948.
Place: Northern States Power Co., Minneapolis.
Presiding Officer: J. O. Kvalsten, Chairman.
Subject: "Airport Lighting Technique and Equipment," by R. E. Madigan, Line Material Co. Report on National I.E.S. Boston Conference, September, 1948, by L. B. Paist and S. F. McGowan.
Attendance: 38.
Remarks: Dinner meeting.

NORTHEASTERN REGION

Connecticut Chapter Meeting

Date: October 28, 1948.
Place: Connecticut Light & Power Co., Meriden.
Presiding Officer: K. E. Estler, Chairman.
Subject: "Textile Mill Lighting," by James M. Shute, Bachmann Uxbridge Worsted Corp., Uxbridge, Mass.
Attendance: 52.

Date: November 18, 1948.
Place: Plainville High School.
Presiding Officer: K. E. Estler, Chairman.
Subject: (1) "School Lighting," by C. W. McCormick, Supervisor of Commercial Lighting, The Connecticut Light and Power Co., Waterbury, Conn. (2) Inspection tour of school.
Attendance: 42.
Remarks: Dinner followed meeting.

New York Section Meetings

Date: October 14, 1948.
Place: Consolidated Edison Company Auditorium.
Presiding Officer: Miss Caroline E. Horn, Chairman.
Subject: "Lighting Progress, 1948" by Samuel G. Hibben, Director of Applied Lighting, Lamp Division, Westinghouse Electric Corporation, Bloomfield, N. J.
Attendance: 107.

Date: November 4, 1948.
Place: Consolidated Edison Company Auditorium.
Presiding Officer: Miss Caroline E. Horn, Chairman.
Subject: "Lighting in Europe" by Dr. Ward Harrison, Director and Consultant for Curtis Lighting, Inc., and Thompson Electric Co., Cleveland, Ohio.
Attendance: 135.

Residence Lighting Forum of New York Section

Date: October 7, 1948.
Place: General Electric Auditorium, New York City.
Presiding Officer: Ruby Redford, Chairman.
Subject: (1) "Four Degrees of Residential Lighting" and "Analysis of Available Lighting for Reading in Bed" by Myrtle Fahsbender, Director of Residence Lighting, Westinghouse Electric Corp., Bloomfield, New Jersey. (2) "Methods of Illuminating Art Objects and Pictures" by Thomas Smith Kelly, New York Lighting Consultant. (3) "An Appraisal of Kitchen Lighting Equipment" by Jan Reynolds, Home Lighting Specialist, Sylvania Electric Products, New York City.
Attendance: 84.

Date: November 18, 1948.
Place: Residence of Mr. and Mrs. W. F. Hosford, Blueberry Point, Butler, N. J.
Presiding Officer: Ruby Redford, Chairman.
Subject: Inspection trip of exceptionally lighted home.
Attendance: 90.
Remarks: Refreshments were served prior to the meeting.

Technical Forum of New York Section

Date: October 14, 1948.
Place: General Electric Auditorium.
Presiding Officer: Theodore O. Jorgensen, Chairman.
Subject: "Development of Color Standards" by Dr. I. H. Godlove, Director of Research, General Aniline & Film Corp.
Attendance: 64.

Date: November 4, 1948.
Place: General Electric Auditorium.
Presiding Officer: Theodore O. Jorgensen, Chairman.
Subject: "Technological Advances in Color Engineering in the Manufacture of Illuminants" by G. B. Buck, II, General Electric Co., Nela Park, Cleveland.
Attendance: 51.

PACIFIC NORTHWEST REGION

British Columbia Chapter Meetings

Date: September 16, 1948.
Place: North Vancouver High School.
Presiding Officer: R. G. Scott, Chairman.
Subject: Inspection tour of classrooms—including those which had been relighted and redecorated according to the recommended practice of the I.E.S.
Attendance: 64.

Date: October 22, 1948.
Place: Auditorium of the Canadian General Electric Co., Ltd.
Presiding Officer: A. E. Simpson, Chairman.
Subject: Installation of Officers. "Present and Future Applications of Luminescence and Ultra-Violet Light" by J. DeMent, Portland.
Attendance: 76.

Inland Empire Chapter Meeting

Date: October 21, 1948.
Place: Masonic Temple, Spokane, Washington.
Presiding Officer: D. E. Mozes, Chairman.
Subject: "Light Sorcery"—General Electric Show.
Attendance: 400.
Remarks: Joint meeting with Spokane Section, A.I.E.E.

Oregon Section Meetings

Date: October 13, 1948.
Place: Congress Hotel, Portland.
Presiding Officer: J. D. Webster, Vice-Chairman.
Subject: (a) Review of technical papers at Boston Conference, and (b) Slides showing the latest developments in lighting installations by Walter E. Potter, District Sales Engineer, Lamp Division, General Electric Co.
Attendance: 36.

Date: November 10, 1948.
Place: Congress Hotel, Portland.
Presiding Officer: R. E. Lange, Chairman.
Subject: "Harnessing Light for a Job" by Paul Davis, Holophane District Engineer.
Attendance: 48.

Puget Sound Section Meeting

Date: October 29, 1948.
Place: Town and Country Club, Seattle.
Presiding Officer: Kenneth Hollingsworth, Chairman.
Subject: Review of National Technical Conference at Boston by Kenneth Hollingsworth; and review of Dr. Harmon Ellensburg Conference by Bill Creech.
Attendance: 41.
Remarks: Luncheon meeting. Announcement of officers and appointments for 1948-1949.

THIRD INTERNATIONAL LIGHTING EXPOSITION

(Continued from page 29)

as one of the high spots of the entire week.

The Place of Glass in Lighting — For the Thursday morning session, it is hoped to have the President of Edison Electrical Institute as Chairman. The principal speaker will be one of the nation's leading engineers and his subject will be one of exceptional interest to the lighting industry. The Thursday morning demonstrations will be conducted by Corning Glass Works, typifying "What's New in Glass for Lighting."

Color Problems — On Friday, the committee has invited the President of the National Electrical Contractors Association to act as general Chairman. A Forum on Color will be conducted by one of the nation's outstanding authorities on this subject, who will present many actual examples as illustrations.

Advance Registration — In order to make Registration easy for those attending and to eliminate the usual tedium of having to stand in line on arrival, the Exposition Committee has provided "Early Bird" Advance Registration Tickets, which involve no cost or obligation. By filling out and sending in one of these Advance Registration Tickets, anyone desiring to attend is assured that his badge of admission will be ready for him when he calls for it at the Registration Desk of the Third International Lighting Exposition and there will be no waiting. Sending this in also assures him that his name will be placed on the list of those who are to receive any further information that may be issued for the benefit of those planning to attend. These Advance Registration Tickets may be obtained, in quantities sufficient to supply all those who are interested by requesting them from any of the Exhibitors.

POSITION WANTED

Young man seeking position designing portable lamps and lighting fixtures to fit in with decorative schemes. Experience with leading eastern designer and manufacturer. Full prospective on request. Address Box 500, Illuminating Engineering, 51 Madison Ave., New York 10, N. Y.

SALES REPRESENTATIVES WANTED:

With lighting or engineering experience and following of electrical wholesalers and jobbers, to handle a complete line of fluorescent and incandescent lighting equipment. Our products are not highly competitive. Territories open as of January 1st, 1949: N. Y. State; Pennsylvania; Delaware, Maryland and District of Columbia; Virginia; Georgia; Florida. Give full details of present lines now handled, ability, experience, background and following. Address Box 100—Publications Office, Illuminating Engineering, 51 Madison Avenue, New York 10, N. Y.

SUSTAINING MEMBERS

Acme Electric Corporation
Cuba, N. Y. *J. A. Comstock*

Admiral Lamp Manufacturing Corp.
2326 Indiana Ave., Chicago, Ill. *F. Schwartz*

Advance Transformer Co.
1122 W. Catalpa Ave., Chicago 40, Ill. *Hirsch Epstein*

Alabama Power Co.
Birmingham, Ala. *J. S. Sutherland*

All Bright Electric Products Co.
3917-25 N. Kedzie Ave., Chicago 18, Ill. *Max Klein*

Amalgamated Electric Corp., Ltd.
384 Pape Ave., Toronto, Ont., Canada *D. W. Patterson*

American Concrete Corp.
4727 North Lamon Ave., Chicago 30, Ill. *J. W. Lewis*

American Fluorescent Corp.
5407 Broadway, Chicago, Ill. *William Rusnak*

American Sterilizer Co.
Erie, Pa. *Horace Wm. Alexander*

Appleton Electric Co.
1701-1729 Wellington Ave., Chicago, Ill. *Nils A. Fornblom*

Arkansas Power & Light Co.
Simmons National Bldg., Pine Bluff, Ark. *Max Suddath*

Artistic Lamp Manufacturing Co., Inc.
395 Fourth Ave., New York 16, N. Y. *Henry Perlmutter*

Art Lamp Corp.
1750 W. Fulton St., Chicago 12, Ill. *R. H. Martin*

The Art Metal Co.
1814 E. 40th St., Cleveland 3, Ohio *George E. Glatthar*

Bausch & Lomb Optical Co.
Rochester 2, N. Y. *David L. Williams*

Benjamin Electric Mfg. Co.
Des Plaines, Ill. *John H. Waterbury*

Blue Ridge Glass Corp.
Kingsport, Tenn. *Robert Ingouf*

Board of Water and Electric Light Commissioners
116 W. Ottawa St., P.O. Box 570, Lansing 3, Mich. *John D. Mainight*

Boston Edison Co.
39 Boylston St., Boston 12, Mass. *R. B. Brown, Jr.*

Bright Light Reflector Co., Inc.
Fairfield & State, Bridgeport 5, Conn. *C. E. Scholl*

Brockton Edison Co.
46 Main St., Brockton 67, Mass. *W. A. Forbush*

Buffalo Niagara Elec. Corp.
Buffalo 3, N. Y. *Jack F. Parsons*

Edward F. Caldwell & Co., Inc.
101 Park Ave., New York 17, N. Y. *E. F. Caldwell*

California Elec. Power Co.
P.O. Box 512, Riverside, Calif. *W. S. Fleming*

Cal-Lite, Inc.
12600 S. Yukon Ave., Hawthorne, Calif. *N. L. Urcles*

Calpa Products Company
4116 Chester Ave., Philadelphia 4, Pa. *Paul C. Calissi*

Cambridge Electric Light Co.
46 Blackstone St., Cambridge 39, Mass. *Reginald H. Bowman*

Canadian General Elec. Co., Ltd.
212 King St., Toronto, Ont., *R. M. Love*

Canadian Laco Lamps, Ltd.
745 Guy St., Montreal, Que., Canada *J. Thomas*

Canadian Line Materials, Ltd.
Postal Station H, Toronto 13, Ont., Canada *M. L. E. Messinger*

Central Hudson Gas and Elec. Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
316 Jefferson Ave. S., Peoria 2, Ill. *R. K. Dallas*

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hees*

Central New York Power Corp.
300 Erie Boulevard W., Syracuse, N. Y. *L. D. McCormac*

Central Power & Light Co.
P.O. Box 2121, Corpus Christi, Texas. *James M. Williams*

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery T. Raddin*

Chicago Miniature Lamp Works
1500 North Ogden, Chicago, Ill. *Edward M. Pollack*

Cincinnati Gas & Electric Co.
Fourth & Main Sts, Cincinnati 1, Ohio *J. R. Hartman*

Circlite Corp.
118 So. Clinton St., Chicago, Ill. *George Gumbery*

City of Burbank, California Public Service Department
174 W. Magnolia Boulevard, Burbank, Calif. *J. H. McCambridge*

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif. *P. Diederich*

City of Riverside Electric Light Dept.
3854 Mulberry St., Riverside, Calif. *L. W. Grayson*

City Lighting Department
1015 Third Ave., Seattle 4, Wash. *P. C. Spaeart*

Colonial Electric Products, Inc.
1-115 Market St., E. Paterson, N. J. *Wallace M. Woodworth*

Colonial Premier Co.
466 W. Superior St., Chicago 10, Ill. *Richard Weis*

Commercial Light Company
841 W. Washington Blvd., Chicago, Ill. *Michael R. Fine*

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill. *Ralph G. Raymond*

The Connecticut Light & Power Co.
250 Freight St., Waterbury 91, Conn. *A. V. S. Lindsley*

Conowingo Power Co.
118 North St., Elkton, Md. *A. R. Granger*

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *Clarence Law*

Consolidated Gas, Elec. Lt. & Pwr. Co. of Baltimore
100 W. Lexington St., Baltimore 1, Md. *R. H. Tillman*

Consumers Power Co.
212 Michigan Ave., W. Jackson, Mich. *D. E. Korn*

Consumers Public Pwr. Dist.
1452-25th Ave., Columbus, Nebraska *W. H. Sinke*

Corning Glass Works
Corning, N. Y. *A. S. Tylor*

(*Note*: Names of Official Representatives appear in Italics)

Coyne Electrical School, Inc.
500 So. Paulina St., Chicago 7, Ill.
John Hanan

Crescent Electric Supply Co.
765 Iowa St., Duquesne, Iowa
Titus B. Schmid

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*
Crouse Hinds of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station, Chicago 38, Ill. *Darwin Curtis*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave., Leaside, Toronto 12, Ont. *H. L. Wright*

Cutler Light Manufacturing Co.
2026-28 N. 22d St., Philadelphia 21, Pa.
Robert T. Cutler

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas
W. G. Moore

The Daunt Corp.
120-126 Sutton St., Brooklyn, N. Y.
Alfred G. Strutt

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo.
D. J. Biller

The Dayton Power & Light Co.
205 E. First St., Dayton 1, Ohio
H. S. Nonneman

Dazor Manufacturing Corp.
4483 Duncan Ave., St. Louis 10, Mo.
P. L. Read

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del.
W. A. F. Pyle

Dept. of Water & Power, City of Los Angeles, Bur. of Pwr. & Lt.
Box 3669 Terminal Annex, 207 So. Broadway, Los Angeles, Calif. *C. P. Garman*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich.
L. E. Tayler

Detroit Steel Products Co.
2250 E. Grand Blvd., Detroit 11, Mich.
W. Clifton Randall

Dobkin Electrical Supply Co.
329 W. Madison St., Chicago, Ill.
Jerry Dobkin

E. I. duPont de Nemours & Co., Inc. (Fabrics & Finishes Div.)
Wilmington 98, Del. *S. W. Quisenberry*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa.
G. W. Ousler

Duro Test Corporation
2321 Hudson Blvd., North Bergen, N. J.
James L. Cox

Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass.
Louis Gilman

East Side Metal Spinning & Stamping Corp.
1 W. 34th St., New York 1, N. Y.
M. A. Kremer

Ebasco Services, Inc.
2 Rector St., New York 6, N. Y.
W. E. Parrott

Efengee Electrical Supply Co.
671 W. Washington St., Chicago 6, Ill.
H. J. Bennett

Electrical Information Publications, Inc.
20 E. Mifflin, P.O. Box 232, Madison, Wis.
Fenton Kelsey, Jr.

Elec. Service Mfg. Co.
17th & Cambria Sts., Philadelphia, Pa.
E. A. Leinroth

Electric Supply Corp.
701 W. Jackson Blvd., Chicago 6, Ill.
L. B. Mangione

Electrical Testing Laboratories, Inc.
79th St. & East End Ave., New York City 21, N. Y. *Preston S. Millar*

Electrified Industry
20 No. Wacker Drive, Chicago, Ill.
B. J. Martin

Electro Manufacturing Co.
2000 W. Fulton St., Chicago 12, Ill.
L. K. Schoenbrod

Electrolier Mfg. Company, Ltd.
5849 Boyer St., Montreal, Que., Canada.
John Issenman

Ender Manufacturing Corp.
260 West St., New York 13, N. Y.
Jules Levenstein

Englewood Electrical Supply Co.
5801-03 So. Halsted St., Chicago, Ill.
Ray O'Leary

Famous Fluorescent Lighting Co.
762 N. Ogden Ave., Chicago 22, Ill.
Jack R. Stone

Federal Electric Company, Inc.
8700 S. State St., Chicago, Ill.
John H. Gachet

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass. *A. G. Neal*

Fluorescent Equipment & Mfg. Co.
2570 Superior Ave., Cleveland 14, Ohio
Leonard S. Freeman

Fluorescent Maintenance Co., Inc.
1480 S. Robertson Blvd., Los Angeles 35, Calif. *Leonard K. Black*

Fluores-O-Lite Co.
Evans Terminal, No. Broad St., Hillside, N. J.
Meyer H. Silverman

The Fostoria Pressed Steel Corp.
Fostoria, Ohio *E. L. Bates*

H. A. Framburg & Co.
3320-28 Carroll Ave., Chicago 24, Ill.
Stanley A. Framburg

The France Mfg. Co.
10325 Berea Rd., Cleveland 2, Ohio
J. H. Mayne

The Frankelite Co.
1425 Rockwell Ave., Cleveland 14, Ohio
Dave Frankel

Franklin Design Service Division of Safeway Stores, Inc.
P.O. Box 660, Oakland 4, Calif. *H. J. Dutton*

The Frink Corporation
27-01 Bridge Plaza North, Long Island City, N. Y. *Theo. J. Brassel, Jr.*

Gallagher-O'Brien Electric Co., Inc.
712 N. State St., Chicago 10, Ill.
Frank A. Gallagher

Garden City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harney

General Electric Co., Apparatus Dept.
Schenectady, N. Y. *A. F. Dickerson*

General Electric Co., Lamp Dept.
Cleveland 12, Ohio *Ward Harrison*

General Electric Supply Corp.
1260 Boston Ave., Bridgeport, Conn.
W. W. Booth

General Lighting Products Co.
16 Delancy St., Newark 5, N. J.
Nathan H. Eglowstein

General Outdoor Advertising Co., Inc.
515 So. Loomis St., Chicago, Ill. *R. E. Nevius*

The Georgia Power Co.
Electric Building, Atlanta 1, Ga.
Charles A. Collier

Gibson Manufacturing Co.
1919 Piedmont Circle, N. E., Atlanta, Ga.
R. R. Gibson

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
F. D. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
James Gillinder

Gleason-Tiebout Glass Co.
99 Commercial St., Brooklyn 22, N. Y.
Charles W. Gleason

Globe Lighting Products Co., Inc.
397 Seventh Ave., Brooklyn, N. Y.
Isidor Rosenblatt

Golde Manufacturing Co.
1214 West Madison, Chicago 7, Ill.
E. W. Goldberg

Goodrich Electric Co.
4600 Belle Plaine Ave., Chicago 41, Ill.
L. R. Jorgensen

Grand Rapids Store Equip. Co.
1340 Monroe Ave., N. W., Grand Rapids 2, Mich. *Kenneth C. Welch*

Graybar Electric Co., Inc.
420 Lexington Ave., New York 17, N. Y.
Raymond C. Kinney

Gruber Brothers
125 S. 1st St., Brooklyn 15, N. Y.
Harry J. Gruber

Gulf States Utilities Co.
Box 2951, Beaumont, Texas *Clarence Barron*

The Edwin F. Guth Co.
2615 Washington Ave., St. Louis 3, Mo.
Fred E. Guth

Hartford Electric Light Co.
266 Pearl St., Hartford 3, Conn.
W. D. Gorman

Hawkins Electric Co.
1447 Washington Blvd., Chicago 7, Ill.
R. E. Hill

A. Ward Hendrickson & Co., Inc.
45-47 Pearson St., Long Island City 1, N. Y.
Joseph T. Manucia

Holdenline Co.
2301 Scranton Road, Cleveland 13, Ohio
H. E. Ingraham

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Houston Lighting & Power Co.
P.O. Box 1700, Houston 1, Texas
H. O. Clarke

Hydro-Electric Power Comm. of Ont.
620 University Ave., Toronto, Ontario, Canada
R. L. Hearn

Hyland Electrical Supply Co.
700 West Jackson Blvd., Chicago, Ill.
Chas. H. Weicensang

Illinois Power Co.
134 East Main St., (L Box 511 B), Decatur, Ill. *Allen Van Wyck*

Illuminating Engineering Company
2347 E. Nine Mile Road, Hazel Park, Mich.
Bert C. Pretzer

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa
John M. Hollingsworth

Iowa Public Service Co.
400 Commercial St., Waterloo, Iowa
Dell B. Raymond

Jeannette Shade & Novelty Co.
N. Fourth St., Jeannette, Pa. *H. N. Crock*

Jefferson Electric Co.
Bellwood, Ill. *L. Mauerer*

Jersey Central Power & Light Co.
501 Grand Ave., Asbury Park, N. J.
Thomas R. Dobson

Joleco Corporation
2513 Baldwin St., St. Louis, Mo.
George Ledbetter

Jones Metal Products Co.
West Lafayette, Ohio *H. Boyer*

Joslyn Mfg. & Supply Co.
3700 So. Morgan St., Chicago 9, Ill.
J. H. Fahey

Kahn Manufacturing Co., Inc.
2051 N. 19th St., Milwaukee, Wis.
Charles F. Kahn

Kansas City Power & Light Co.
P.O. Box 679, Kansas City 10, Mo.
John M. Arthur, Jr.

Kansas Gas & Electric Co.
P.O. Box 205, Wichita, Kans. *H. W. Hobson*

The Kayline Company
2480 E. 22nd St., Cleveland 15, Ohio
M. A. Eskins

Kelso-Brunett Electric Co.
223 W. Jackson Blvd., Chicago 6, Ill.
Sigmund A. Hollinger

Keystone Electric Manufacturing Co.
2328-36 E. Tioga St., Philadelphia 34, Pa.
Leonard M. Siegel

The Kirlin Company
3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Kopp Glass, Inc.
Swissvale, Pa. *F. C. Ashe*

Kubec Electric Co.
630 W. Jackson Blvd., Chicago 6, Ill.
Fred A. Girten

The La Salle Lighting Products, Inc.
145 Seneca St., Buffalo 3, N. Y.
Nelson E. Zickerman

Leander Electric Manufacturing Corp.
3500 N. Kedzie St., Chicago 18, Ill.
Walter Glass

The Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia 44, Pa.
I. M. Stein

The Leland Electric Co.
1501 Webster St., Dayton, Ohio
Harold A. Cline

Libbey Owens Ford Glass Co., Plaskon Division
2112-24 Sylvan Ave., Toledo, Ohio
Dr. M. H. Bigelow

Lighting & Lamps
114 East 32nd St., New York, N. Y.
James Krieger

Light Control Company
3217 Casitas Ave., Los Angeles 26, Calif.
Stanley E. Lindahl

Lighting Incorporated
1834 So. Figueroa St., Los Angeles, Calif.
Harry Marsh

Lighting Materials Limited
1319 Seymour St., Vancouver, B. C., Canada
E. E. Ackland

Lighting Products, Inc.
2259 W. Park Ave., Highland Park, Ill.
D. E. Dunne

Lightolier Co.
11 East 36th St., New York 16, N. Y.
H. Stollnitz

Line Material Co.
800 North 8th St., Milwaukee 1, Wis.
M. C. Harsh

Litecontrol Corp.
36 Pleasant St., Watertown 72, Mass.
Paul H. Lamson

The Lloyd Products Co.
Drawer C, Edgewood Station, Providence 5, R. I.
Guy H. Burt

Louisiana Power & Light Co.
142 Delaronde St., Station "A" New Orleans, La.
C. L. Osterberger

Lumidor Mfg. Co. Inc.
4801 E. 50th St., Los Angeles 11, Calif.
Arthur N. Nielson

Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

T. R. Lyda Manufacturers Rep.
4922 Washington Blvd., Indianapolis, Ind.
T. R. Lyda

Lynn Gas & Electric Co.
90 Exchange St., Lynn, Mass. *James A. Cook*

Macbeth Corp.
227 West 17th St., New York, N. Y.
Norman Macbeth

Malden Electric Co.
157 Pleasant St., Malden, Mass.
Donald S. Bennett

Markel Electric Products, Inc.
145 E. Seneca St., Buffalo 3, N. Y.
D. L. Ripley

Markstone Manufacturing Co.
1917 N. Springfield Ave., Chicago 5, Ill.
M. J. Marks

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Canada
Henri Martineau

Metalcraft Products Company
306-08 Cherry St., Philadelphia 6, Pa.
Alex Abel

Metal Window Institute
Cheltenham, Penn. *George Hingston*

Metropolitan Edison Co.
412 Washington St., Reading, Pa.
E. J. Ingram

Metropolitan Electrical Supply Co.
20 N. Jefferson St., Chicago 6, Ill.
H. J. Privat

The Miller Co.
Meriden, Conn. *G. W. Beals*

Mississippi Glass Co.
209 Fifth Ave., New York City, N. Y.
E. H. Hobbie

Mississippi Power Co.
Gulfport, Miss. *E. M. Shearer*

Mississippi Power & Light Co.
Lampton Building, Jackson 113, Miss.
Henry B. Sargent

Mitchell Manufacturing Co.
2525 Clybourn Ave., Chicago 14, Ill.
Bernard Mitchell

Mobilite Inc.
400 Mercer St., Jersey City, N. J.
Sidney Solmar

Modern Light & Equip. Co.
3812 S. Wabash Ave., Chicago, Ill.
M. L. Offenberg

Montana-Dakota Utilities Co.
831 Second Ave. So., Minneapolis 2, Minn.
W. L. Hayes

Municipal Light and Power Dept.
City of Pasadena, California, 302 City Hall, Pasadena 1, Calif. *E. L. Bettannier*

Mutual Sunset Lamp Mfg. Co., Inc.
540 Empire State Bldg., New York 1, N. Y.
Norris Thau

The Narragansett Electric Co.
49 Westminster St., Providence 1, R. I.
C. R. Broadhead

National Chemical & Manufacturing Co. Luminall Paint Div.
3617 So. May St., Chicago 9, Ill.
John Marshall Zic

National Lighting Products
4221 W. Van Buren St., Chicago 24, Ill.
D. J. Epp

Nebraska Power Co.
720 Electric Bldg., Omaha 2, Neb.
G. A. Walker

Nelson-Tombacher Co.
81 Prospect St., Brooklyn, N. Y.
M. J. Tombacher

New Bedford Gas & Edison Light Co.
693 Purchase St., New Bedford, Mass.
W. S. Fenstermacher

New Orleans Public Service, Inc.
317 Baronne St., New Orleans, La.
S. L. Drumm

New York Power & Light Corp.
Albany 1, N. Y. *Coburn D. Hollister*

Northern Electric Co. Ltd.
1620 Notre Dame St., West Montreal, Quebec, Canada *F. P. Lahey*

Northern Indiana Public Service Co.
5265 Hohman Ave., Hammond, Ind.
J. C. Sackman

Northern States Power Co.
Minneapolis 2, Minn. *Carl T. Bremicker*

Ohio Edison Co. (Akron Div.)
Akron 8, Ohio *R. F. Hartenstein*

The Ohio Power Co.
301-315 Cleveland Ave., S. W., Canton 2, Ohio
C. B. Marin

The Ohio Public Service Co.
P.O. Box 6058, Cleveland 1, Ohio.
C. L. Dunn

Oklahoma Gas & Electric Co.
Box 1498, Oklahoma City 1, Okla.
E. W. Gray

Omaha Public Power District
720 Electric Bldg., Omaha 2, Nebraska
E. E. Schwalm

Overbagh & Ayres Mfg. Co.
411 S. Clinton St., Chicago 77, Ill.
Cortes N. Sprankle

Pacific Gas & Electric Co.
245 Market St., San Francisco 5, Calif.
O. R. Doerr

Pacific Power & Light Co.
Portland 4, Oregon *D. B. Leonard*

Peerless Electric Ltd.
1909 Pratt Ave., Outremont, Quebec, Canada
L. A. Van Duzer

Wm. Penn Fluorescent Light Mfg. Co.
1639 So. Broad St., Philadelphia, Pa.
William Ranieri

Pennsylvania Electric Co.
535 Vine St., Johnstown, Pa.
Frank R. Knowles

Pennsylvania Power Co.
19 E. Washington St., New Castle, Pa.
P. G. Dingledy

Pennsylvania Power & Light Co.
901 Hamilton St., Allentown, Pa.
J. M. Stedman

Pennsylvania Wire Glass Co.
1612 Market St., Philadelphia 3, Pa.
Frank L. Martin

The Perfeclite Co.
1457 E. 40th St., Cleveland, Ohio
Joseph L. Jaffe, Jr.

Philadelphia Electric Co.
1000 Chestnut St., Philadelphia 5, Pa.
H. P. Liversidge

Philadelphia Electrical & Mfg. Co.
1228 North 31st St., Philadelphia 21, Pa.
H. L. Werd

Phoenix Glass Co.
Monaca, Pa. *D. G. Cameron*

Pierce Electric Company
367 West Adams St., Chicago 6, Ill.
John H. Pierce

Pittsburgh Plate Glass Co.
Grant Bldg., Pittsburgh, Pa. *R. B. Tucker*

Pittsburgh Reflector Co.
403-411 Oliver Bldg., Pittsburgh 22, Pa.
H. C. Zinsmeister

Planet Products Inc.
1501 S. Ladin St., Chicago 8, Ill.
Nathan E. Passman

Polaroid Corp.
730 Main St., Cambridge, Mass.
Walter Lown

Portland General Electric Co.
Electric Bldg., Portland 5, Ore. *I. W. Fitch*

The Potomac Edison Co.
55 E. Washington St., Hagerstown, Md.
S. S. Bradford

Public Service Co. of Colo.
900 Fifteenth St., Denver, Colo. *G. B. Buck*

Public Service Co. of Indiana, Inc.
110 N. Illinois St., Indianapolis 9, Ind.
G. O. Stewart

Public Service Co. of Northern Illinois
72 West Adams St., Chicago 3, Ill.
G. K. Hardacre

Public Service Co. of Oklahoma
Box 201, Tulsa 2, Okla. *C. N. Robinson*

Public Service Electric & Gas Co.
80 Park Place, Newark 2, N. J.
H. P. J. Steinmetz

Puget Sound Power & Light Co.
860 Stuart Bldg., Seattle 11, Wash.
Frank McLaughlin

The Pyle-National Co.
1334 N. Kostner Ave., Chicago 51, Ill.
T. E. McDowell

Quadrangle Mfg. Co.
32 So. Peoria St., Chicago 7, Ill.
Dwight E. Worrell

Quebec Hydro-Electric Commission
106 Craig St., West, Montreal, Canada
Paul E. Poitras

Quebec Power Co.
229 St. Joseph St., Quebec, Canada
Jean Saint-Jacques

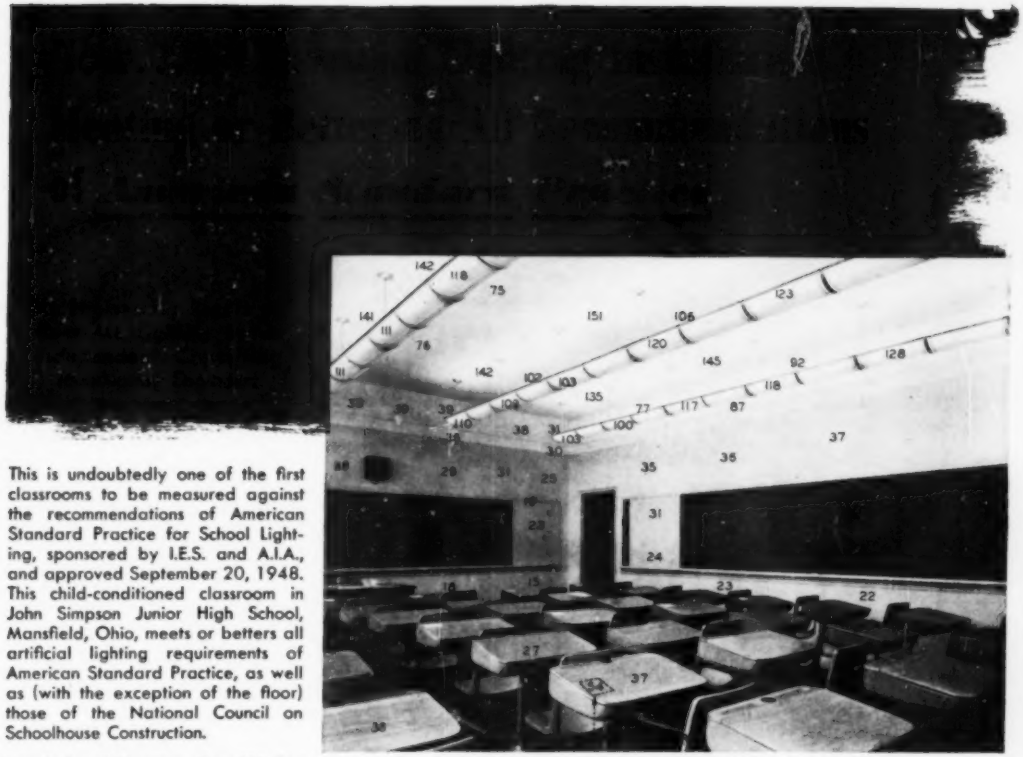
Rambusch Decorating Co.
40 W. 13th St., New York 11, N. Y.
Edward Rambusch

Revere Electric Mfg. Co.
6009-17 N. Broadway, Chicago 40, Ill.
Van N. Marker

Revere Electric Supply Co.
757 West Jackson Blvd., Chicago, Ill.
Floyd Fernau

Ritter Co., Inc.
409 West Ave., Rochester 11, N. Y.
Gordon K. Cameron

(Continued on page 27A)



This is undoubtedly one of the first classrooms to be measured against the recommendations of American Standard Practice for School Lighting, sponsored by I.E.S. and A.I.A., and approved September 20, 1948. This child-conditioned classroom in John Simpson Junior High School, Mansfield, Ohio, meets or betters all artificial lighting requirements of American Standard Practice, as well as (with the exception of the floor) those of the National Council on Schoolhouse Construction.

Description of Classroom: Room 101, John Simpson Junior High School, Mansfield, Ohio. 30 feet long, 22 feet wide, 12 feet high. Ceiling white. Walls yellow and turquoise. Natural finish seating. Light green chalkboards. Ivory tackboards. Double row of diffusion screens mounted at windows.

Lighting Installation: Four continuous rows of two-lamp, 40W Wakefield Star units with luminous indirect plastic reflectors using 3500° white fluorescent lamps.

Weather Conditions: The survey was made on November 26, 1948, seven months after installation. The day was dark and cloudy with sky brightness so low the brightness of the diffuser at the window was approximately the same as that of the wall adjacent to it (66 footlamberts).

A copy of the complete detailed engineering report is yours for the asking. It is interesting to note that all equipment and materials used in this classroom are regularly available from manufacturers' stocks, and we will be glad to supply manufacturers' names, catalog numbers and descriptions of materials on request. Write to The F. W. Wakefield Brass Company, Vermilion, Ohio.

Comparison of Brightness Ratios

	Room 101 John Simpson Junior High School	American Standard Practice for School Lighting	National Council on Schoolhouse Construction
Brightness of paper to brightness of desk top	1 to 1/1.6	1 to 1/3	1 to 1/5
Brightness of paper to brightness of floor	1 to 1/9	1 to 1/10	1 to 1/5
Brightness of paper to brightness of ceiling	1 to 2.78 (max.)	1 to 10	1 to 10
Brightness of luminaires to surfaces adjacent to them in the visual fields	3.4 to 1 (max.)	20 to 1	no recommendation
Brightness difference in the surrounding field between the brightest and darkest surfaces	18.5 to 1	no recommendation	50 to 1
Brightness difference in the peripheral field between the brightest and darkest surfaces	24 to 1	no recommendation	250 to 1
Lighting level	38 ft. c. lowest; 69 average	30 ft. c. min.	20 ft. c. min.

Comparison of Reflectances

Ceiling	Above 85%	80 to 85%	85% min.
Walls	62 to 70%	50 to 70%	50% min.
Trim	48%	30 to 40%	40 to 60%
Tackboards	67%	50 to 60%	no recom.
Chalkboards	24%	15 to 20%	30% max.
Desk Tops	30 to 55%	35 to 50%	30 to 40%
Floor	22%	15 to 30%	30 to 40%

Wakefield Over-ALL Lighting

A BASIC CLASSROOM TOOL

I.E.S. PUBLICATIONS

Available for your lighting reference bookshelf. Items are numbered for identification with coupon below.

(1) I.E.S. LIGHTING HANDBOOK

One volume, 850 pages. A complete reference guide providing basic information on lighting. For architects, engineers, designers and others who plan, install and manufacture lighting systems and equipment. $7.50 per copy; $5 in lots of 10 or more.

RECOMMENDED PRACTICES

(2) SCHOOL LIGHTING. Newest American Standard Practice for help in planning, selling, installing and maintaining lighting quality in schools.

(3) Home Lighting. Recommended Practice.

(4) Office Lighting. Recommended Practice.

(5) Lighting Practices for Stores and Other Merchandising Areas.

(6) Street and Highway Lighting. American Standard Practice.

Those above available at 50 cents per copy or in quantity as follows: First 4 copies, 50 cents each; next 20, 25 cents each; all over 24, 15 cents each.

(7) Industrial Lighting. American Recommended Practice. 1-10 copies, 25 cents each; next 40, 20 cents each; over 50, 15 cents each.

LIGHTING DATA SHEETS

Actual lighting installations with engineering data and fully illustrated, covering such subjects as lighting for the metal working, textile, automobile and other industries; residential, store and office lighting. Published in yearly series for the past 12 years ,at $1 per series, from Series 6 on.

(8) Special price. Series 6 to 12 inclusive at $5.25.

OTHER I.E.S. PUBLICATIONS: **(9) Art Gallery Lighting, 50 cents per copy up to four; next 20, 25 cents; over 24, 15 cents each. (10) Standard Method for Measuring and Reporting Illumination from Artificial Sources in Building Interiors, 10 cents. (11) Lighting Performance Recommendations for Portable and Installed Residence Luminaires, per copy 50 cents. (12) Residential Wiring Design Handbook, 25 cents each. (13) Farmstead Wiring Design Handbook, 40 cents each.**

LIGHTING COURSE MATERIAL: **(14) Experiments with Light, for science students, 25 cents. (15) Fundamentals of Illumination (outline), 25 cents. (16) Lessons in Practical Home Illumination (outline), 25 cents. (17) Lighting Design Problems Course (outline), $1.50; 10 or more, $1.25.**

Indicate publications wanted by number. Enter name and address. Clip out and mail.

ILLUMINATING ENGINEERING SOCIETY
Publications Office
51 Madison Avenue
New York 10, New York

Date _____

Please send me, addressed as below, copies of I.E.S. Publications which I have indicated by number.

☐ My check (money order) is enclosed. ☐ Bill me.

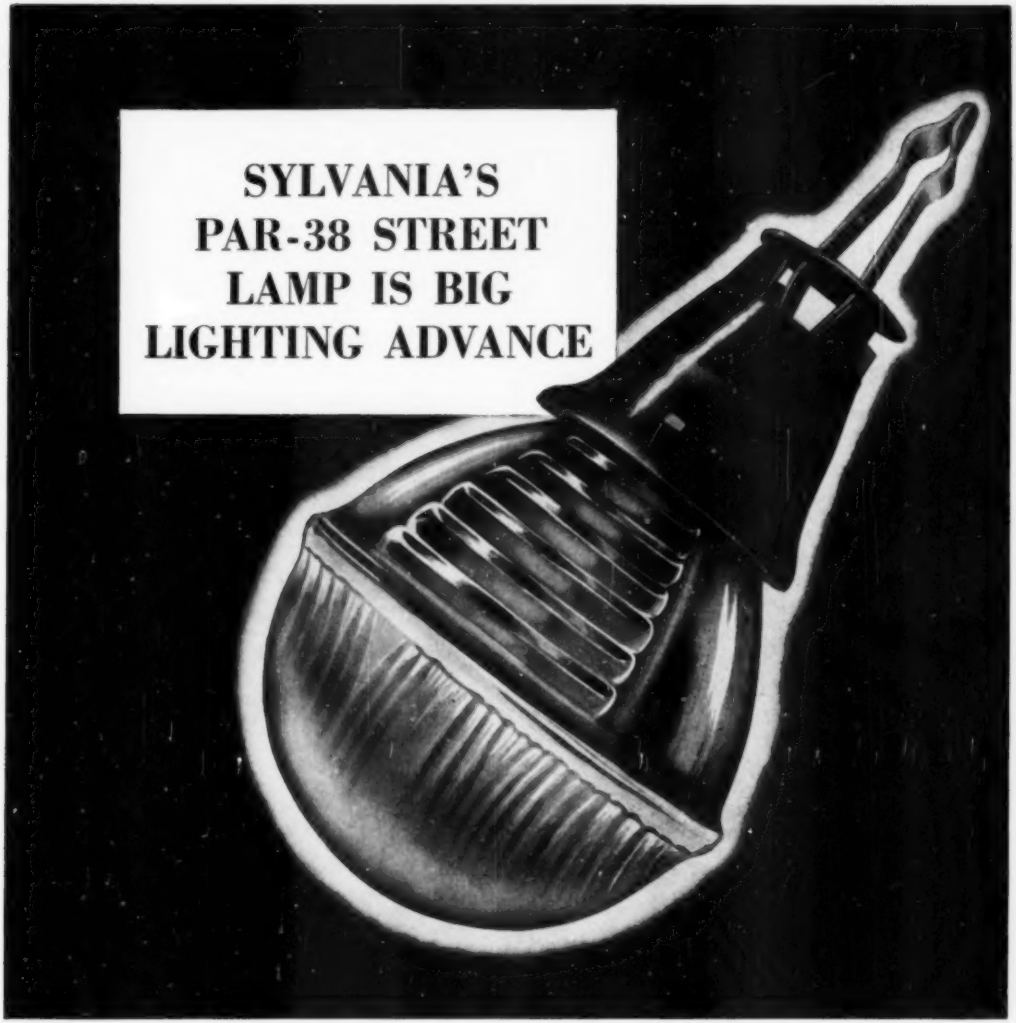
_____ copies ☐
_____ copies ☐
_____ copies ☐
_____ copies ☐
_____ copies ☐

Name _____

Street _____

City _____ Zone _____ State _____

SYLVANIA'S PAR-38 STREET LAMP IS BIG LIGHTING ADVANCE



THIS newest member of the Sylvania hard glass reflector lamp family was developed specifically for the illumination of streets and highways in residential sections, and offers most of the advantages of the larger prismatic reflector as well as many advantages of its own.

Here's a lamp whose reflector never needs polishing . . . it's built-in . . . light output is maintained at high levels throughout the life of the lamp. In addition, since the new PAR-38 is for use in residential areas, the cut-off of light is lowered to 55° on the house side and 65° on the street side, giving *more light where needed* and avoiding annoying light in second story windows! Also, this lamp is less subject to breakage than ordinary types.

The same leadership and engineering skill that developed the PAR-38 Street Lamp have made possible noteworthy advances in the fields of Radio, Television, FM, and Electronics.

ALL PRODUCTS MADE BY SYLVANIA ELECTRIC CONSUME ENERGY—MORE THAN 10,400,000,000 KWH PER YEAR

SYLVANIA ELECTRIC

Division Offices: Atlanta, Boston, Buffalo, Chicago, Cleveland, Detroit, Kansas City, Los Angeles, New York, Philadelphia, San Francisco, Seattle, Washington

New hotel sparkles with uses General Electric

NEW General Electric lamps are combined with new ideas to make the lighting in Cincinnati's new Terrace Plaza hotel ultra-modern and highly efficient.

Newer light sources—particularly G-E slimline fluorescent lamps and PAR lamps—are used to streamline the hotel. They provide mood-setting atmosphere with varied brightness levels and make for efficient flow of traffic. They provide easy, comfortable seeing in guest rooms (see photo at right), lobbies, dining rooms, corridors and work rooms throughout the hotel.

Here again, it is shown that improved lighting is a sound investment in better business, greater profit. Architects: Skidmore, Owings & Merrill. Lighting designer: Abe Feder.

1 **THE BRIGHT,** cheerful glow of G-E slimline lamps above each pair of doors welcomes guests to their rooms. Translucent room numbers are lighted by 6-watt fluorescent lamps.

2 **AT THE REGISTRATION** desk in the 8th floor lobby, 100 foot-candles of light make work easier and more accurate, and draw traffic to the desk. There are 156 G-E slimline lamps installed in the glass canopy above.

3 **WAITING FOR** the elevator is more pleasant under the cool, flattering light of General Electric slimlines. Two rows of recessed lamps provide long, unbroken lines of light.

4 **THIS SPARKLING** clean cafeteria whets appetites by using 100 foot-candles of light on food displays. G-E 150-watt PAR-38 lamps are used here and over the tables.

5 **FLATTERING LIGHT** for the bathrooms is attained by mounting 42-in. T6 slimline lamps at either side of the mirror. Lamps are in the flattering new soft white color.

modern lighting ideas-lamps throughout!

In double rooms, G-E slimline lamps provide restful, modern atmosphere. Built-in PAR lamps make reading easy.

6 THE UNIQUE "Gourmet Room" uses G-E 150-watt recessed ceiling spotlights to put 75 foot-candles of light on the tables. They can be dimmed to any desired level.

7 ON ANY LIGHTING JOB, whether big or small, use General Electric lamps throughout. G-E lamp quality is backed by over 480 tests and inspections. And the more than 10,000 types and sizes of G-E lamps are constantly improved by research to *STAY BRIGHTER LONGER.*

G-E LAMPS

GENERAL ELECTRIC

HANDIEST CATALOG YET!

. . . SAY HUNDREDS OF USERS

A FIXTURE FOR EVERY LIGHTING REQUIREMENT

SEND FOR OUR COMPLETE 48 PAGE POCKET CATALOG

• • WEST COAST • •
807 WEST 11TH ST.
LOS ANGELES · 15 · CALIF.

L.J. SEGIL CO.
MANUFACTURERS OF
Fluor De Le
LIGHTING EQUIPMENT
ELJAY

• • MAIN OFFICE • •
2500 W. NORTH AVE.
CHICAGO · 47 · ILL.

BEFORE—In the absence of any daylight, this bank was always gloomy. The bare lamps in the fixtures, plus light strips over the tellers' cages, never gave adequate light anywhere and certainly did not flatter the architecture.

RIGHT—Home Savings Bank, Albany, New York. After relighting under the direction of Gander, Gander and Gander, Architects, and Walter S. Stewman, Jr., Consulting Engineer.

AFTER—Thirty-two Rambusch Downlites recessed in the main ceiling give high intensity light over the floor below, while twenty-two 750 watt wall urns give indirect light on the ceiling to create a cheerful atmosphere and improved working conditions. Average intensity 28 foot candles.

BANK ILLUMINATION

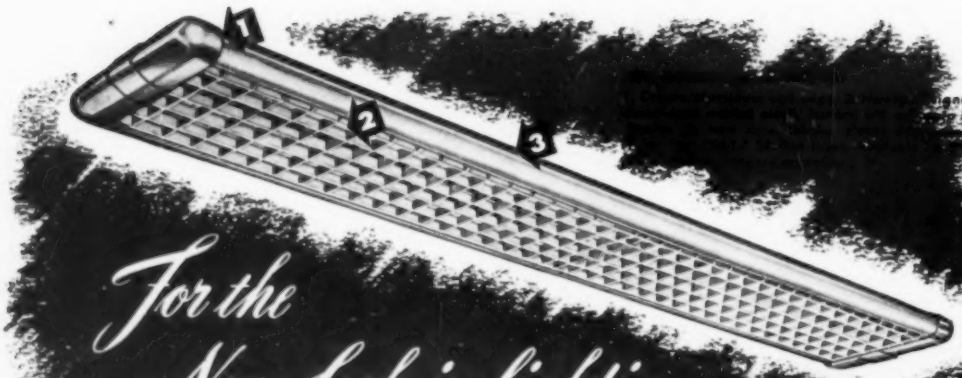
The name Rambusch has become synonymous with architectural lighting. As interior designers of furnishings and decorations for Churches, Banks, Theatres, Auditoriums, Libraries, State Capitols, etc., Rambusch has the background for developing lighting equipment in harmony with any monumental building. Our large staff of engineers—men with national reputations—have spent a lifetime coordinating the aesthetic approach with all the latest developments in lighting technique.

Our offices, design rooms, and shops are combined in one building equipped for many types of lighting fabrication. Here you may see every process from the first sketch to the finished fixture.

Field Representatives in every section of the country are at your service.

Let us help you solve your architectural lighting problems. Data sheets on architectural lighting sent on request.

RAMBUSCH *Designers and Manufacturers* **40 West 13th Street, New York 11, N. Y.**



For the New Look in lighting . . .

Leader

NEW HORIZON Fluorescent Fixture

● A look at *tomorrow* in luminaires: our NEW HORIZON. A slimmed-down silhouette that blends naturally and easily into smart architectural trends. But—above all—this latest of LEADERS has these definite operational advantages:

The beautiful NEW HORIZON (nesting instant-start Slimline lamps) is *easy to install . . . easy to service . . . releases more light with less surface glare.* And it gives its abundance of light longer . . . at *lower maintenance costs.*

For full information on the carefully-conceived advantages of the *New Horizon* series, write today.

LEADER ELECTRIC COMP[illegible]

3500 NORTH KEDZIE • CHICAGO 18, ILL. • We[illegible] [illegible]land 6, Calif.

[illegible] especially de-[illegible] available in one lam[illegible] wee lamp (NHO-380[illegible] [illegible]ation, 100, 200 or 300 milliampere op[illegible]

The NEW HORIZON Incandescent Spotlight. Excellent for highlighting displays. Available for corner installations (Cat. No. LS-40) or between fixtures in continuous runs (Cat. No. LS-70).

HOW DO YOU SELECT LIGHTING EQUIPMENT?

If you are the average lighting engineer you will be concerned with the following considerations:

QUANTITY OF LIGHT	INSTALLATION
QUALITY OF LIGHT	MAINTENANCE
APPEARANCE	OVERALL COST

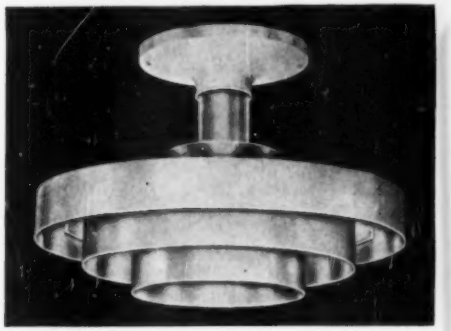
Integrated Lighting by Silvray makes your selection easier because all of these factors were considered and included before our distinctive designs left the drawing board.

SILVRAY "SEALED REFLECTOR" SYSTEMS . . . *for Indirect Lighting*

Indirect systems afford the finest quality lighting for the "Light for Seeing" applications of schools, offices and drafting rooms. And Silvray sealed reflector systems are the ultimate in efficiency, simplicity and ease of maintenance. As pioneers in the development of Silvered Bowl lighting equipment, Silvray integrates light control with distinctive modern fixture designs.

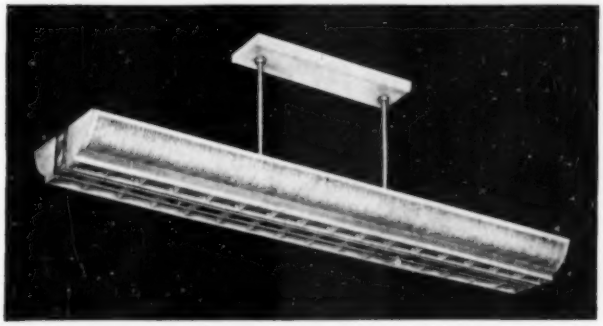
INTEGRATED LIGHT CONTROL

Light source and light control are integrated in the "sealed reflector" system of the Silvered Bowl Lamp. A coating of pure silver deposited on the bulb and permanently sealed to it keeps dust and dirt away from the reflector. This is the key to Silvray's outstanding lighting efficiency.



SILVRAY LIGHTING SYSTEMS

Finest in Fluorescent



IN FLUORESCENT LIGHTING as in incandescent, Silvray luminaries have the built-in characteristics which combine high quality lighting performance with rugged mechanical construction and pleasing appearance. The Silvray principle of integrated lighting insures a balanced lighting system. Silvray engineering provides quality lighting, good styling and dependability at moderate cost.

THE 1500 LINE

Functional simplicity combined with efficiency of 87.5% make the #1500 line the choice of critical architects and engineers. Available in two, three and four ring designs for ceiling and pendant mounting and for 150 to 1000 watt lamps. The silvered bowl lamp is replaced thru the bottom ring. Replacing the lamp restores fixture to initial efficiency.

THE 711 LINE

A new semi-indirect fluorescent lighting system incorporating important new features:

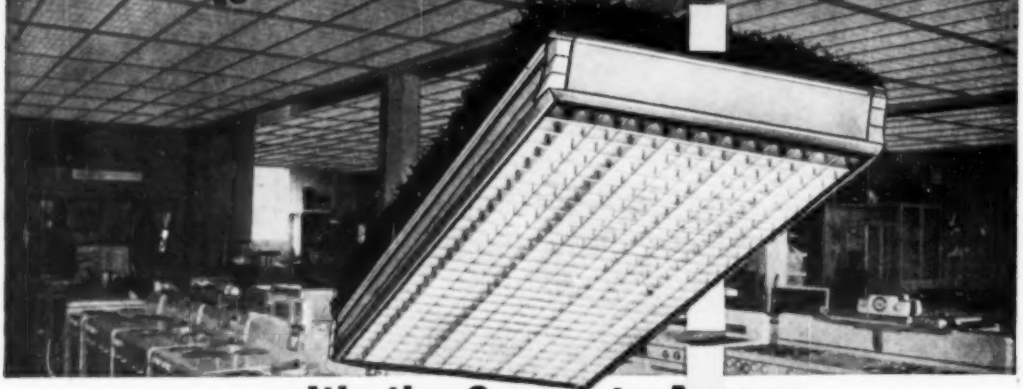
- **BRIGHTNESS MODIFICATION**
  Surface brightness ranging from 2 to ½ cp. per sq. in. controlled by type of side panel chosen
- **HIGH EFFICIENCY**
  70% to 80% ETL Test
- **EASY MAINTENANCE**
  Hinged side panels for relamping and cleaning
- **ADVANCED STYLING**
  Narrow cross section, graceful lines
- **SIMPLIFIED INSTALLATION**
  Four hanger styles for individual or continuous row mounting; Extendor and Adjustor for leveling and alignment

SILVRAY LIGHTING INC.

OFFICE: R.K.O Bldg., Radio City, New York, N. Y.
FACTORY: Bound Brook, New Jersey

DISTRIBUTED BY GRAYBAR

LPI Fi-bord PUTS A STOP to louver maintenance problems



It's the Complete Answer

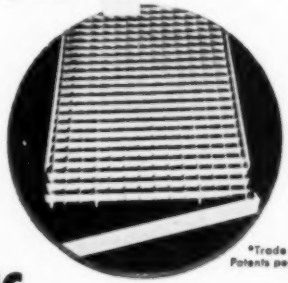
FI-BORD* (fiber-board) Louvers are exclusive with LPI—the *only* louvers offering *all* these amazing *new* features:

1. **NO MAINTENANCE** . . . You *don't clean* Fi-Bord; you *replace it*—at less cost than is required for cleaning ordinary louvers.
2. **FIVE COLORS** . . . Fi-Bord is available in white and in pastel shades of blue, pink, green, and yellow.
3. **EASY, SPEEDY INSTALLATION** . . . In less than two minutes per unit, Fi-Bord can provide a whole new color scheme.
4. **HIGH REFLECTION, LOW BRIGHTNESS** . . . Reflection factors up to 79%. Scientific louver design provides correct brightness control with light cut-off 38° in all directions.
5. **NEW REFLECTING SURFACES** . . . with each replacement. There's no light loss due to cleaning or scratched surfaces.

AND FI-BORD Louvers are fire resistant, light in weight, compact, easy to ship, and easy to handle.

FI-BORD Louvers are standard equipment on the LPI PANELUX*, the luminaire that gives "Panels of Light." *It's a complete* fixture and does not require a combination of fixture and false ceiling.

Write today for PANELUX Bulletin No. 420, or contact the LPI lighting representative nearest you. LPI fixtures are union-made (I. B. E. W.—A. F. of L.) and sold nationally through leading electrical wholesalers.



*Trade marks applied for
Patents pending on all features

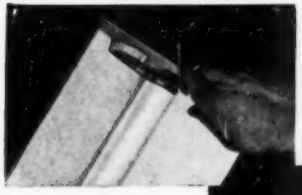
Lighting **PRODUCTS, INC.**

HIGHLAND PARK, ILLINOIS

When you SELL fluorescent fixtures, SELL the best . . . SELL LPI

TURRET* LAMPHOLDERS

Have the features your customers want



The Turret lampholder greatly minimizes the costly replacements of broken lampholders.

Maintenance men need no longer waste time fussing with safety gadgets.

Provides protection from the hazard of lamps falling out of the fixtures.

Lamps can be inserted from either end of the fixture by depressing either face of the Turret lampholder with one end of the lamp, and slipping the other end in place. Holds lamps firmly in contact.

TURRET* LAMPHOLDERS

Have the features fixture manufacturers want

✔ Can be mounted with two screws on any flat surface, preferably with lock washers under screw heads. Starter receptacles are located between the lamps.

✔ Stripped and tinned leads can be inserted through the entrance holes in the face of the Turret lampholder. Binding screws are then tightened through the holes in the bottom of the lampholder to make permanent pressure contacts.

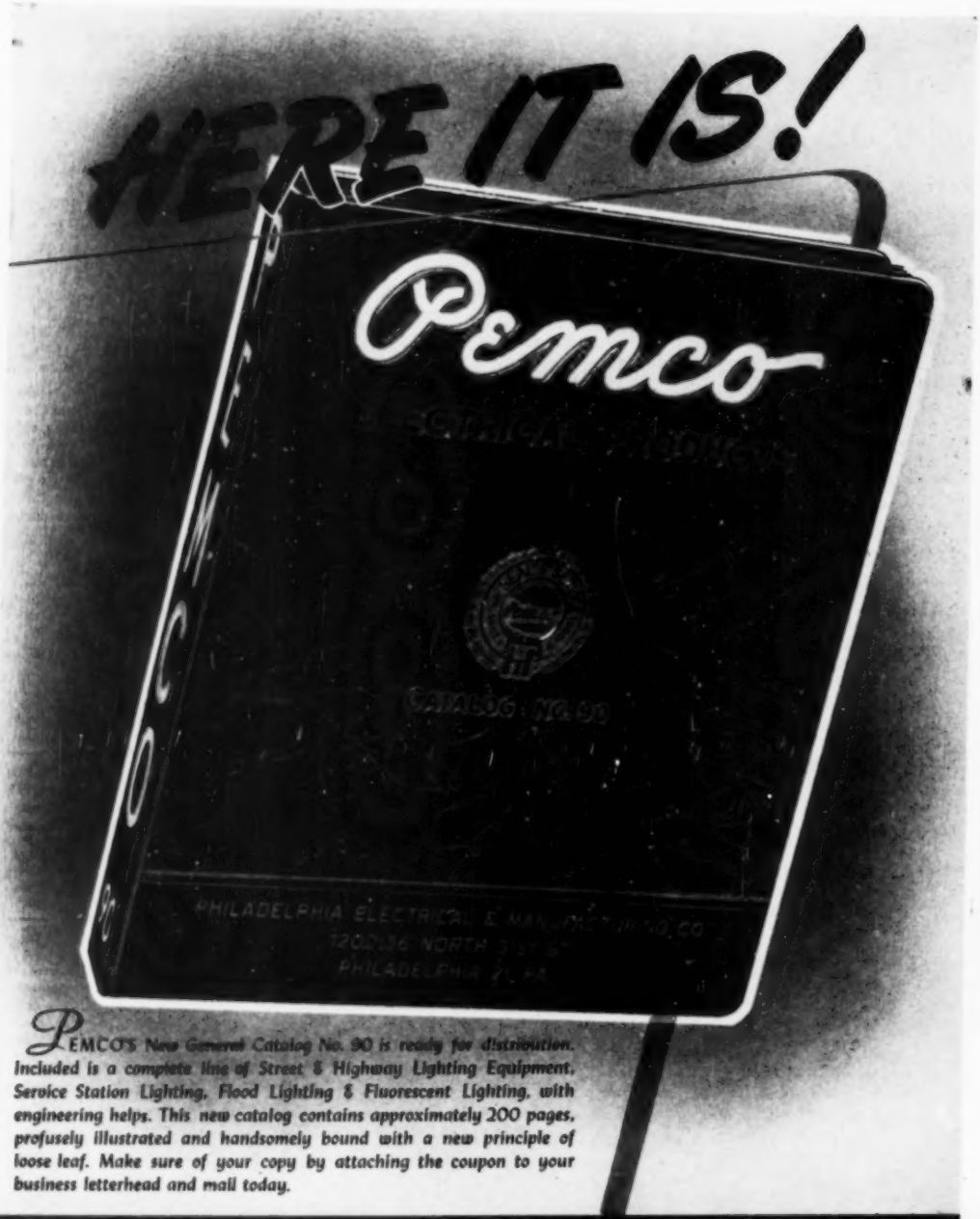
✔ The pleasing design of Turret lampholders adds to the appearance and the value of any fluorescent lighting fixture.

✔ Turret lampholders can be used in a wide variety of arrangements. They can be mounted singly or in multiple groups. They are available to accommodate two or three lamps.

For further information, write to Section Q17-94, General Electric Company, Bridgeport 2, Connecticut.

*TRADE MARK REG. U.S. PAT. OFF.

GENERAL ELECTRIC



PEMCO'S *New General Catalog No. 90 is ready for distribution. Included is a complete line of Street & Highway Lighting Equipment, Service Station Lighting, Flood Lighting & Fluorescent Lighting, with engineering helps. This new catalog contains approximately 200 pages, profusely illustrated and handsomely bound with a new principle of loose leaf. Make sure of your copy by attaching the coupon to your business letterhead and mail today.*

PHILADELPHIA ELECTRICAL & MFG. CO.

1200-36 N. 31st ST. PHILADELPHIA 21, PA.

PHILADELPHIA ELECTRICAL & MFG. CO.
1200-36 N. 31st STREET, PHILA. 21, PA.
Please send copy of your New General Catalog No. 90 to

Name ..... Position .....

SEARCH LEADS TO 1000-FIXTURE ORDER FOR FRINK *L-I-N-O-L-I-T-E* SERIES 22

WANTED

by BRAUN in California

C. F. Braun & Co., engineers and constructors at Alhambra, California, sought a fluorescent lighting fixture which would be suited to their own needs, and adaptable to other types of installations. After studying the products of various fixture manufacturers, they selected the *L-I-N-O-L-I-T-E* Series 22 fixture.

EXECUTIVE STAFF DINING ROOM at C. F. Braun and Co. demonstrates *L-I-N-O-L-I-T-E* Series 22 in large, high ceilinged rooms.

***L-I-N-O-L-I-T-E* SERIES 22 . . . one of Frink's fifteen expertly engineered standard designs. Glass panels with maximum transmission and shadow-free diffusion are framed to minimize dirt accumulation. Starters accessible without removing lamps. Ballasts accessible without dismantling fixture. Available for 2, 3 or 4 lamps. Hinged glass or louver bottom.**

FOUND

at FRINK in New York

A thoroughly practical fixture; highly efficient in operation; completely adaptable for ceiling or hanger mounting, singly or in continuous runs; and with unique features (see description above) for easy, economical maintenance and installation.

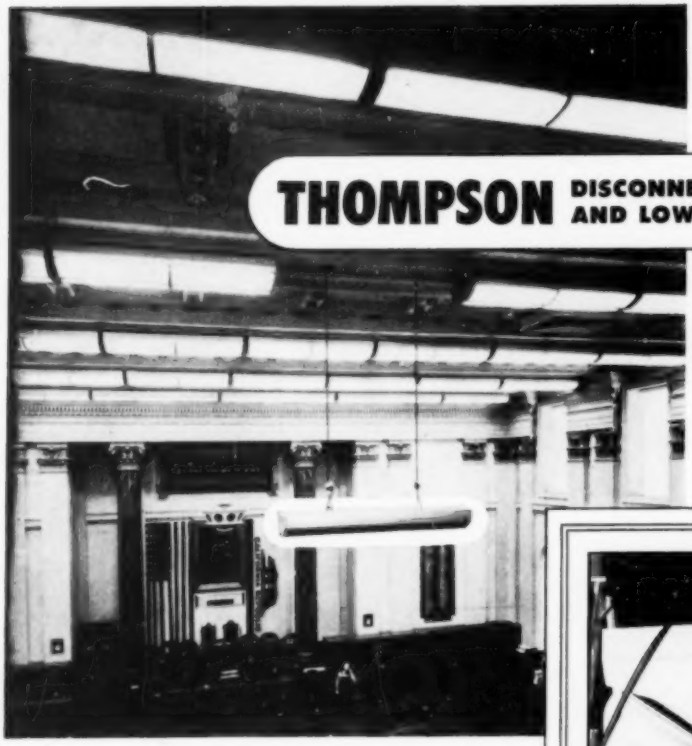
P.S. Braun placed an order for 1000 units!

ENGINEER'S OFFICE—Fixtures blend with smart interior. All *L-I-N-O-L-I-T-E* fixtures are handsomely designed and made with craftsman-like attention to every detail.

HOW YOU CAN FIND complete lighting satisfaction. The Frink *PLAN-O-LITE* sample packet forcefully demonstrates the advantages of planned fluorescent lighting. It gives you 8 custom-designed *PLAN-O-LITE* layouts and engineering data for typical Frink installations, with photos of the results. **FREE** for the asking while supply lasts. Write today to Dept. I-1F.

THE FRINK CORPORATION

27-01 BRIDGE PLAZA NORTH, LONG ISLAND CITY, N. Y.



THOMPSON DISCONNECTING AND LOWERING HANGERS

make high bay FLUORESCENT LIGHTING *feasible*

Fixture being lowered

The problem of cleaning and relamping a high bay fluorescent lighting system approximately 33 feet above floor level and containing 382—40 watt 3500° white tubes can only be solved economically with Thompson Disconnecting and Lowering Hangers. That's why they were specified as an integral part of the lighting system in the State Assembly Chamber at Sacramento, Calif.

Each fixture is lowered separately to desk top level—electrically "dead." A simple test block arrangement is provided to facilitate final inspection after cleaning and relamping. The 250-pound units are easily winched back to operating position and are automatically re-connected.

MAKES AIR CONDITIONING PRACTICABLE

The former incandescent lighting system requiring a total connected load of 52,000 watts caused such a temperature rise that when added to normal summer temperature, it made the air conditioning system practically ineffective. The use of fluorescent 40-watt 3500° white tubes provided 40 ft. candles at desk height and the low temperature rise solved the air conditioning problem.

Fixture being Relamped and Tested

The easy access to lighting fixtures afforded by Thompson Hangers permits frequent cleaning — scheduled relamping — and assures constant foot candles on the desk surfaces to specification.

THOMPSON
DISCONNECTING & LOWERING
HANGERS

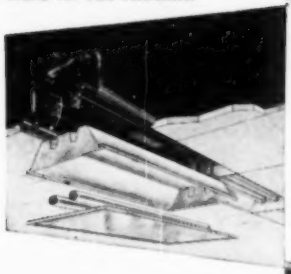
We invite you
to use THOMPSON Engineering Service

THE THOMPSON ELECTRIC CO.
1101 POWER AVENUE • CLEVELAND 14, OHIO

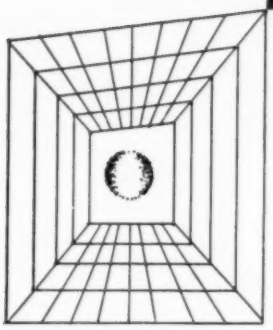
It Pays to Plan Lighting at the Drawing Board the MILLER Way

1

All parts are of quality construction. Channels are Bonderized for rust resistance.



Room-length rows of Miller Troffers supply well diffused light in this drafting area.



IT PAYS — because, besides providing the good lighting required. Miller Fluorescent Troffer Lighting Systems are a definite structural aid, most flexible for working out esthetic ceiling design and insuring architectural harmony . . . "CEILINGS UNLIMITED".* IT PAYS — because their wide range of reflector enclosures meet the lighting requirements of varied interiors. IT PAYS — because installation is simplified by Miller patented Ceiling Furring Hanger.

Miller lighting service is all-inclusive. It covers the needs of planned commercial and industrial lighting. Miller field engineers and distributors, conveniently located, are at your call.

THE miller COMPANY

SINCE 1911

ILLUMINATING DIVISION, MERIDEN, CONNECTICUT

ILLUMINATING DIVISION Fluorescent, Incandescent, Mercury Lighting Equipment HEATING PRODUCTS DIVISION Domestic Burners and Liquid Fuel Burners ROLLING MILL DIVISION Phosphor Bronze and Brass • Sheets, Strips and Rolls

*Reg. Trademark U. S. Pat. Off.

A CERTIFIED FLEUR-O-LIER

The Meritliter 500 Series

FOR SCHOOLS • OFFICES AND LOCATIONS WHERE ILLUMINATION IS OF UTMOST IMPORTANCE.

THROUGH an original and unique design of SHIELDING, the Meritliter 500 Series produces an illumination that is easy on the eyes, yet exceptionally efficient according to lighting standards. Available in two or three 40 watt lamps.

All metal sides are of two-piece construction, to produce an edge-glow effect combined with a hinged louver bottom of 35° transverse and 25°— 30° longitudinal light cut-off.

These certified Fleur-O-Lier's are so constructed as to meet all safety requirements plus low installation and maintenance costs.

The appearance is excellent as the entire fixture is finished in Endur 300° white, with removable end ornaments of chrome for end to end mounting.

For improving present lighting conditions or for new construction, get in touch with an Ender lighting specialist.

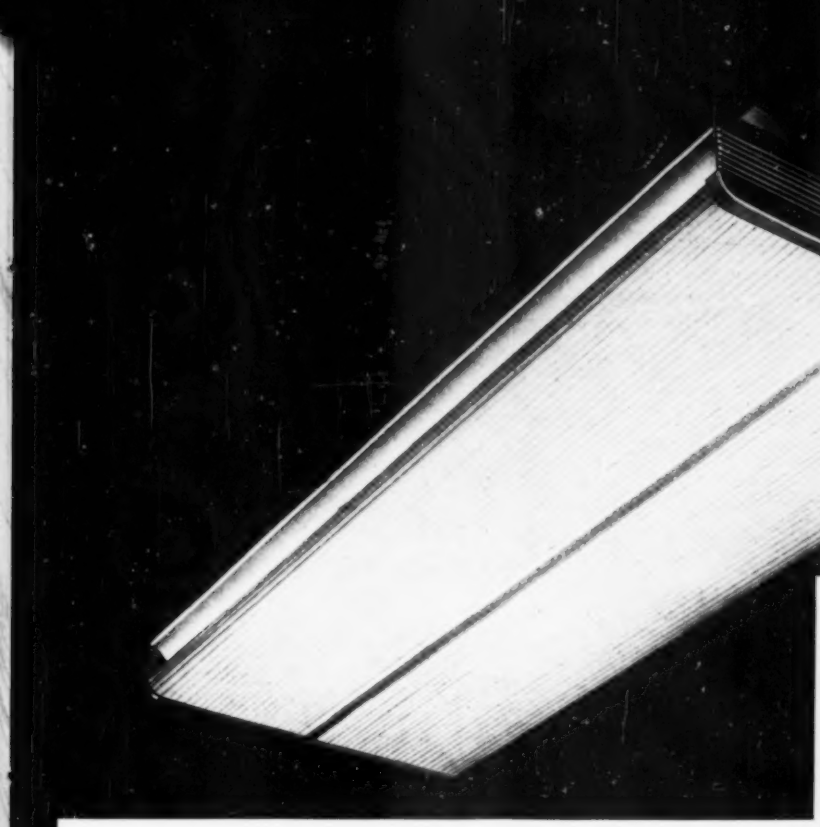
Write today for a folder describing the Meritliter 500 Series and complete E.T.L. reports.

ALL ENDER LIGHTING FIXTURES ARE E.T.L. TESTED

ENDER MANUFACTURING CORP.

260 West Street Dept. 700a New York 13, N. Y.

DISTRIBUTED ONLY THROUGH LEADING ELECTRICAL WHOLESALERS



Light Conditioning for Sale...

A well-known architect recently said, "Ideas spread slowly but surely. Just as people are prone to pass up retail establishments that are not air conditioned, in the same manner they are passing up places that are not well lighted, shall we say, *light conditioned*."

This principle holds true for any lighting installation. Better than anything else it explains why SOLARLITE has been able to develop better fixtures engineered to utilize fully the latest in light sources.

Take the SOLARLITE PANEL LUMINAIRE, for example, at the top of this page. Judge this new fixture critically... study its slim, clean lines. Now, see it in use in the installation snapshots at the right. Note how beautifully it blends into any type background... retail store, bank or office.

And it is every bit as functional as it is beautiful—with its remarkable low surface brightness and high light efficiency.

The SOLARLITE PANEL LUMINAIRE represents just one fixture in a broad, adaptable line. If you care to write for a copy of our new "*Lighting Fixture Digest*," you can have all the facts on file for quick reference.

Solar Light Manufacturing Co.
1357 SOUTH JEFFERSON STREET, CHICAGO 7, ILLINOIS

BLACKBOARDS HAVE ONLY 5-15% LIGHT REFLECTION!

PLUS+LITE BOARDS HAVE 60-86% LIGHT REFLECTION

and WASHABLE Plus+Lite Crayons
(Erase with a DRY cloth)

- Plus+Lite Crayons in 6 spectrum colors, brown and black.
- Higher color combination legibility.
- Makes a modern, pleasant interior.

*Plus+Lite comes in Grey, Light Green, Light Yellow, and Buff as well as White.

The Chatfield-Clarke Co.
1639-37 Tenth St.
Santa Monica, Calif.
Please send me FREE, one Plus + Lite Board with samples of Plus + Lite WASHABLE Crayons, (erase with a DRY cloth) and the story of how Plus + Lite can better serve all our requirements.
Name
School or Company
Address
City Zone State

WRONG
WRITE

PLUS + LITE

The Chatfield-Clarke Co.
1639-37 Tenth St.
Santa Monica, Calif.
Please send me FREE, one Plus + Lite Board with samples of Plus + Lite WASHABLE Crayons, (erase with a DRY cloth) and the story of how Plus + Lite can better serve all our requirements.
Name
School or Company
Address
City Zone State

THE CHATFIELD-CLARKE COMPANY 1639-37 TENTH ST., SANTA MONICA, CALIFORNIA

SUSTAINING MEMBERS

(Continued from page 78)

Rochester Gas & Electric Corp
89 East Ave., Rochester 4, N. Y.
Frank C. Taylor

Rockland Light & Power Co.
Nyack, N. Y. *D. S. Schaab*

Rohm and Haas Co.
222 W. Washington Sq., Philadelphia 5, Pa.
F. W. Tetzlaff

Ruby-Phillite Corp.
32-02 Queens Blvd., Long Island City 1, N. Y.
Louis Phillips

Ruby Lighting Corp. of California
1212 So. Olive St., Los Angeles, Calif.
Ben Ruby

Rumsey Electric Co.
1007 Arch St., Philadelphia 7, Pa.
T. W. Lauer

The Safety Car Heating & Lighting Co.
P.O. Box 904, New Haven 4, Conn.
Leonard Pierson

St. Joseph Ry., Lt., Heat & Power Co.
520 Francis St., St. Joseph 2, Mo.
F. P. O'Connor

Sandee Manufacturing Co.
5050 Foster Ave., Chicago, Ill.
Cortes N. Sprankle

Sandel Manufacturing Co.
3618 So. Loomis Place, Chicago 9, Ill.
A. L. Sandel

San Diego Gas & Electric Co.
P.O. Box 1831, San Diego 12, Calif.
A. E. Holloway

Savannah Electric & Power Co.
Savannah, Ga. *J. L. Davidson*

The Scott-Jaqua Co. Inc.
316 Indiana Terminal Warehouse Bldg., Indianapolis, Ind. *C. A. Jaqua*

Schomer Electric Supply
164 S. Broadway, Aurora, Ill.
Daniel Schomer

The Albert Sechrist Mfg. Co.
1717 Logan St., Denver 5, Colo.
K. L. Francis

L. J. Segil Co.
2500 W. North Ave., Chicago, Ill.
Louis Rosenstein

Shawinigan Water and Power Co.
600 Dorchester St., W., Montreal, Que., Canada *J. K. Wilson*

The Sherwin-Williams Co.
101 Prospect Ave., N. W., Cleveland 1, Ohio
J. A. Meacham

The Sight Light Corp.
P.O. Drawer C, Deep River, Conn.
E. L. Canfield

Silvray Lighting, Inc.
R. K. O. Bldg., Radio City, New York 20, N. Y. *J. M. Gilbert*

Sioux City Gas & Electric Co.
515 Fifth St., Sioux City 4, Iowa *C. E. Tracy*

A. L. Smith Iron Co.
217 Everett Ave., Chelsea, Mass.
Joseph Fishman

S & M Lamp Co.
119 West 36th Place, Los Angeles 54, Calif.
Jim Shirrefs

Smoot-Holman Co.
321 No. Eucalyptus Ave., Inglewood, Calif.
L. A. Hobbs

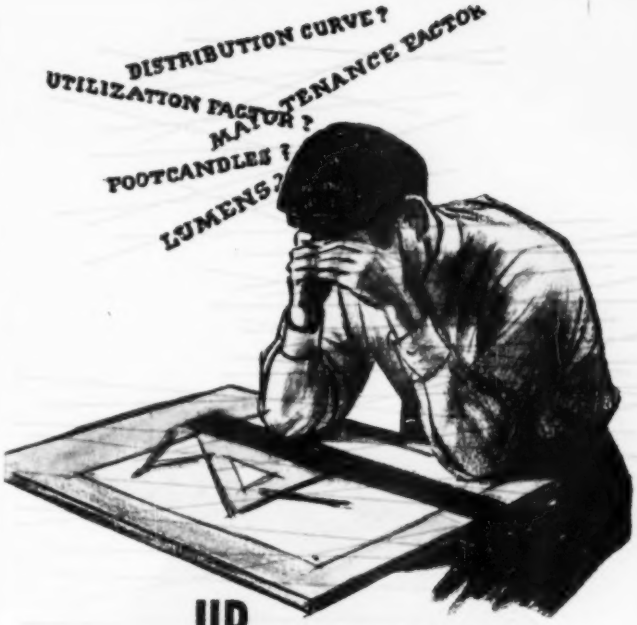
Sola Electric Co.
4633 W. 16th St., Chicago 50, Ill.
L. C. Marschall

Solar Light Mfg. Co.
1357 S. Jefferson St., Chicago 7, Ill.
A. Lazerson

The Solex Co. Ltd.
4060 St. Lawrence Blvd., Montreal, Quebec, Canada *Leo Beauchamp*

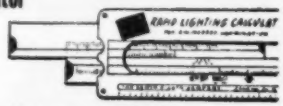
Southern Calif. Edison Co., Ltd.
601 West 5th St., Los Angeles 53, Calif.
G. M. Rankin

(Continued on page 28A)



UP TO THE EARS IN LUMENS?

—this ingenious GUTH Lighting Calculator will save you days of complex computations!



We'll gladly send you one with our compliments.

If you want to save even more time, you'll find your local **Guth** Distributor or Resident **Guth** Engineer competent... and cooperative... in helping you plan functional lighting installations... built around fine **Guth** Fixtures **precision-planned** for efficiency and economy of installation and maintenance.

Do you have our current catalog 44A-1?

Guth LIGHTING

THE EDWIN F. GUTH COMPANY, ST. LOUIS 3, MISSOURI

Leaders in Lighting since 1902

648

STERLING

FOR

Custom Quality

AT COMPETITIVE PRICES

•

Custom-built
Fluorescent Fixtures

Sterling
Silver Glass Reflectors

Show Case
Reflectors

•

STERLING

Reflector and Mfg. Co.

3239-49 WEST GRAND AVENUE

CHICAGO 51, ILLINOIS

I. E. S. LIGHTING DATA SHEETS

. . . offer detailed information concerning many typical lighting application problems. Several series of data sheets cover such subjects as lighting in metal working, textile, automobile and other industries—lighting of stores, offices, churches and hospitals.

•

See Page 10A for Easy Ordering Coupon

•

ILLUMINATING
ENGINEERING SOCIETY
51 MADISON AVENUE
NEW YORK 10, N. Y.

REVOLUTIONARY *Wafer-Thin*

Electro's

SKYLOUVER

. . . with unique Plastic Louvers!

- *Skylouver* provides "Wafer-Thin" construction with handsome panel of durable, non-warping, heat-resistant Polystyrene Plastic.
- Unequalled for schools, offices and installations requiring "right-light." That's because *Skylouver* has ideal cut-off—45° crosswise, 35° lengthwise.
- *Skylouver* is just *one* of 7 adaptations to the famous *Electro Basic Unit Series*, which cuts inventories in half, speeds turnover, adds profits.

ELECTRO MANUFACTURING CORP. **2000 W. Fulton, Chicago 12**

SUSTAINING MEMBERS

(Continued from page 27A)

Southern Canada Power Co. Ltd.
355 St. James St., West, Montreal, Canada
George R. Atchinson

Southern Colorado Power Co.
Box 75, Pueblo, Colo. *G. W. Milliken*

Southern Indiana Gas & Elec. Co.
P.O. Box 569, Evansville 3, Ind.
C. K. Graham

Southern Lighting Mfg. Co.
P.O. Box 2546, Orlando, Fla. *Max K. Aulick*

Southwestern Gas & Elec. Co.
Box 1106, Shreveport, La. *J. E. Elliott*

Southwestern Public Service Co.
Amarillo, Texas *J. E. Cunningham*

Sperti Electric Mfg. Corp.
Beech & Kenilworth Aves., Norwood, Ohio
Ralph A. Lastro

The Spero Electrical Corp.
18223 Lanken Ave., Cleveland, Ohio
Herbert I. Spero

Stanley Electric Mfg. Co.
1234 Carpenter St., Philadelphia 47, Pa.
Bernard S. Heller

Steber Manufacturing Co.
2700 Roosevelt Road, Broadview, Maywood, Ill. *C. S. Davis*

Steiner Electric Co.
3500 Milwaukee Ave., Chicago 41, Ill.
George S. Steiner

Sterling Reflector & Mfg. Co.
3249 West Grand Ave., Chicago 51, Ill.
Anton Oberhuber

Sunbeam Lighting Co.
777 E. 14th Place, Los Angeles 11, Calif.
Herbert L. Krieger

Sun-Ray Fluorescent Co.
600 South Michigan Ave., Chicago, Ill.
Jerome Gimbel

Sylvania Electric Products, Inc.
1057 Summit Ave., Jersey City 7, N. J.
Henry Winston

Tampa Electric Co.
Cass & Tampa Sts., Tampa, Fla. *F. J. Gannon*

Texas Electric Service Co.
Electric Bldg., Fort Worth 1, Texas
R. E. Hendricks

Thompson Electric Co.
1101 Power Ave. N. E., Cleveland 14, Ohio
Thayer B. Farrington

Toledo Edison Co.
Edison Bldg., Toledo 4, Ohio
Charles A. Harrison

Toronto Hydro-Electric System
14 Carlton St., Toronto 2, Ont., Canada
A. W. J. Stewart

Torstenson Glass Co.
3233 N. Sheffield Ave., Chicago 13, Ill.
Elmer L. Torstenson

Triangle Industries
600 W. Adams St., Chicago, Ill.
Leonard Cohen

Tru-Lite Ltd.
824 Notre Dame St., W., Montreal, Que.
Omer M. Trudel

Underwriters' Laboratories, Inc.
207 E. Ohio St., Chicago 11, Ill.
Ferd. Neumer

Union Electric Co. of Missouri
12th & Locust Sts., St. Louis 1, Mo.
W. L. Berry

Union Metal Mfg. Co.
Canton 5, Ohio *W. A. Porterfield*

The United Illuminating Co.
80 Temple St., New Haven 10, Conn.
E. B. Haskell

Utah Power & Light Co.
Box 899, Salt Lake City 10, Utah
W. A. Buckins

(Continued on page 32A)

Do you know...

...that GARCY SEE-MASTERS are available for Every Combination of Lamps

SEE-MASTER SERIES Made for 5 Lamp Combinations

- * 2-40 watt fluorescent
- * 2-85 watt fluorescent
- † 4-40 watt fluorescent
- * 2-96" slimline
- † 4-96" slimline

* 2 lamp fixtures 10 7/16" wide.
† 4 lamp fixtures 14⅜" wide.

An appropriate size for every area — entire installation may be equipped with matching fixtures.

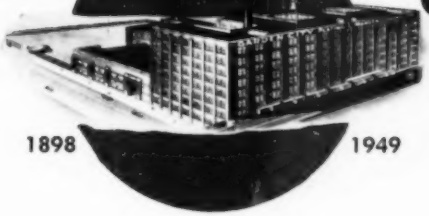
Do you know

...that SEE-MASTERS cost less to install than any similar fixture

- Lead wires furnished at each end of each fixture.
- Coupling members included.
- Basic units installed and connected first, then shielding bodies are attached.
- All parts precision made for perfect, interchangeable fit.

Now starting— OUR SECOND HALF CENTURY

As we enter our 51st year of progress, we look forward to even greater accomplishments with an organization geared to that purpose. For the future, as in the past, we pledge our best efforts and service to the lighting engineers, architects, contractors and wholesalers whose approval of GARCY products is responsible for our success.



1898 1949

Do you know

...that GARCY makes "Spot-a-Lite" units for coupling to end or between any size SEE-MASTER fixture

Write for SEE-MASTER Data or Catalog of Entire Line

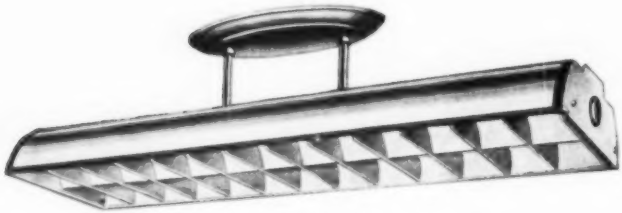
Garcy

Sold by leading wholesalers everywhere . . . or see the GARCY sales representative nearest you.

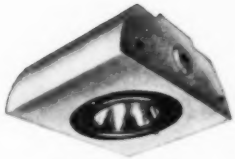
- LUMINAIRES — Fluorescent and Slimline.
- TROFFERS — Fluorescent and slimline — with louver, glass, lens or open bottom.
- ADDA-STRIP — Strip lighting and accessories, including reflectors, decorative end plates and louver shields.
- "Skyline" LOUVERALL CEILINGS.
- "Spot-a-Lite" incandescent units with directionally adjustable spot or flood beam — for individual mounting or coupling to luminaires or troffers.
- SHOWCASE REFLECTORS — Fluorescent and slimline.
- SHOW WINDOW REFLECTORS — fluorescent and slimline.
- INCANDESCENT LIGHTING — down lights, "Drumalier" spots, swivel spot lights, prismatic lens units, etc.
- CUSTOM BUILT and special purpose lighting equipment.

GARDEN CITY PLATING & MFG. CO.
1760 North Ashland Avenue
CHICAGO 22, ILL.

GILL *planned lighting luminaires*



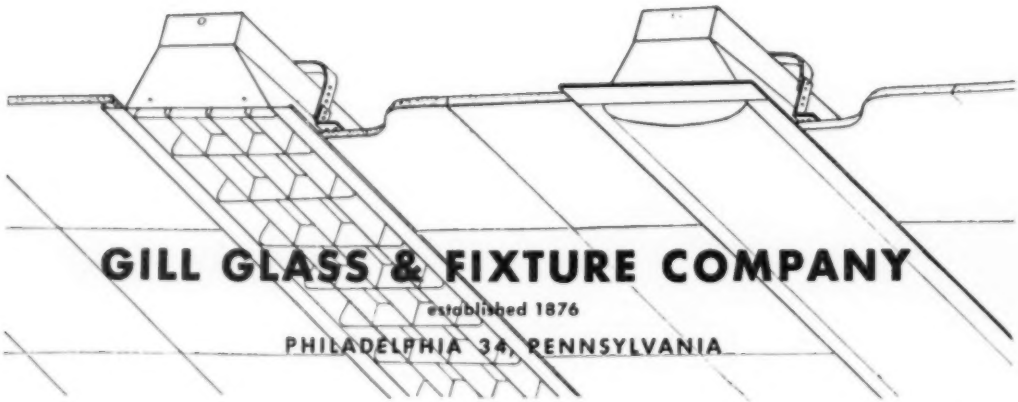
Catalog No. 324



Catalog No. 150

A softly luminous highly efficient FLEUR-O-LIER— approved luminaire for Schoolroom, Office or Store

- No. 324—For use with 2-40 w. Fluorescent Lamps.
  No. 344—For use with 4-40 w. Fluorescent Lamps.
- Louvered from 35°-25° to 45°-45°.
- For pendant or surface mounting.
- Individual or continuous installation.



GILL GLASS & FIXTURE COMPANY

established 1876

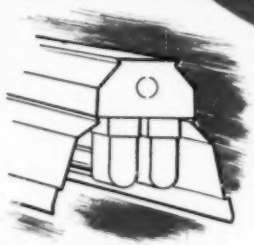
PHILADELPHIA 34, PENNSYLVANIA

NOW!

Rounding out the line of

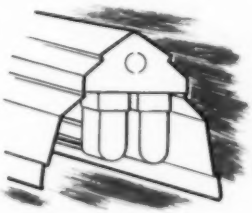
Wheeler "SKILLED LIGHTING"

...New SLIMLINE Fluorescent Fixtures



INDUSTRIAL UNITS

End view of industrial type unit showing flat top. These units are designed for general industrial use under normal atmospheric conditions.



TEXTILE UNITS

End view of textile mill unit showing peaked top especially designed to eliminate frequent cleanings and to offer outstanding protection against humidity.

THIS SMART-LOOKING SLIMLINE fixture offers you more than just sleek beauty . . . it also offers a genuine "Skilled Lighting" unit for use with the new high efficiency SLIMLINE Lamps. Assures extra long service life with minimum maintenance.

Typical of Wheeler engineering thoroughness is the exclusive auxiliary lamp support at center of the fixture to prevent vibration of the 8 foot lamps. Fixture channel is in one piece . . . available in either baked enamel or Wheeler triple-guarded *vitreous porcelain enamel* finish. Reflectors are furnished in vitreous porcelain enamel finish only.

TWO TYPES: INDUSTRIAL-TEXTILE

The new Wheeler SLIMLINE is made for regular industrial application or for textile mill application. Textile mill units have peaked channels to prevent accumulation of fly, lint, dust and moisture.

HIGHEST EFFICIENCY

SLIMLINE lamps operate at the highest efficiency of any lamps. They start instantly . . . no special ballasts needed. If increased intensity is desired, 300 MA ballast is available to replace 200 MA ballast using same lamps.

EASIEST TO HANDLE

SLIMLINE fixtures have only 2 sockets . . . lamps have only 1 terminal pin in each end. Only two 8 foot lamps for a double-length fixture. Get all the facts on the extra value of these new SLIMLINE Units. Write to **Wheeler Reflector Company, 275 Congress St., Boston 10, Massachusetts.**

Distributed Exclusively Through Electrical Wholesalers

Wheeler REFLECTORS

SKILLED LIGHTING

MADE BY SPECIALISTS IN LIGHTING EQUIPMENT SINCE 1881

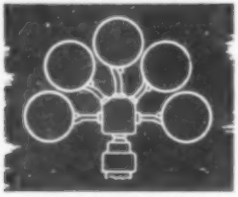
New STEBERLITE

SPOT *and* FLOODLIGHTING

Steberlite Floodlamp Holder S 300 can be installed on conduit fittings, wall brackets or pole slip fitter.

Greatly Widens Lighting Applications

Steberlite, the new lamp holder for 150 watt Par-38 and R-40 lamps, provide flexible inexpensive means of spot and floodlighting business areas, playgrounds, gardens, camps, courts, parking lots, sport and amusement centers—for improved appearance, utility and safety.



By use of Adapter Box No. S 301, clusters up to 5 Steberlites can be quickly assembled as one unit and this in turn fitted to 1½" or 2" pipe or for direct connection to conduit.

Mount Them Singly—in Pairs or Clusters of 3, 4, and 5

Besides better general lighting, Steberlites can be used to direct special attention to displays, statues, buildings and entrances. They can be used singly, in pairs or clusters of 3, 4 and 5. Being compact, weather-proof and completely wired, they are ready for quick assembly and installation indoors or out.

Few Parts to Stock

Just *four* basic units are necessary to serve most requirements—a small inventory does a big profit job. Here's all that is needed:

1. **Steberlite Floodlamp Holder . . . . S 300**
2. **Steberlite Adapter Box . . . . . S 301**
3. **Steberlite Pipe Slip Fitter . . . . . S 302**
4. **Steberlite Accessories and Fittings.**

Sold Through Leading Wholesalers

Write for new Bulletin 125

STEBER

LIGHTING UNITS

STEBER MANUFACTURING CO.

2700 ROOSEVELT ROAD, BROADVIEW (MAYWOOD P. O.), ILLINOIS

SUSTAINING MEMBERS

(Continued from page 28A)

Verd-A-Ray Corp.
615 Front St., Toledo 5, Ohio — *O. S. Levi*

Victory Glass Co.
Jeannette, Pa. — *V. Chirico*

John C. Virden Co.
6009-6103 Longfellow Ave., Cleveland 3, Ohio — *W. G. Sawyer*

John C. Virden, Ltd.
35 Front St., East, Toronto, Ont. — *P. G. Kirkpatrick*

Virginia Electric & Power Co.
Richmond, Va. — *J. G. Holtzclaw*

Voigt Co.
1649 No. Broad St., Philadelphia 22, Pa. — *C. J. Frank*

The F. W. Wakefield Brass Co.
Vermilion, Ohio — *A. F. Wakefield*

The Washington Water Power Co.
P.O. Drawer 1445, Spokane 6, Wash. — *Carl L. Hofman*

The Watson Standard Co.
225 Galveston Ave., Pittsburgh 12, Pa. — *H. E. Striker*

The Welsbach Corp.
1500 Walnut St., Philadelphia 2, Pa. — *H. H. Adams*

Westchester Lighting Company
9 South 1st Ave., Mt. Vernon, N. Y.

Westinghouse Electric Corp.
1216 W. 58th St., Cleveland 2, Ohio (P.O. Box 5817) — *W. F. White*

Westinghouse Electric Corp.
East Pittsburgh, Pa. — *Frank Thornton, Jr.*

Westinghouse Electric Supply Co.
113 North May St., Chicago 7, Ill. — *Henry Czech*

Westinghouse Lamp Div.
Bloomfield, N. J. — *Samuel G. Hibben*

West Penn Power Co.
14 Wood St., Pittsburgh 30, Pa. — *Harry Restofski*

The Wheeler Insulated Wire Co., Inc.
378 Wash. Ave., Bridgeport 4, Conn. — *George B. Horn*

Wheeler Reflector Co.
275 Congress St., Boston 10, Mass. — *K. A. Sawin*

Wiedenback-Brown Co., Inc.
111 Eighth Ave., New York 11, N. Y. — *W. C. Stockberger*

R. & W. Wiley, Inc.
119 Dearborn St., Buffalo 7, N. Y. — *H. B. Alderman*

Wm. Penn Fluorescent Light Mfg. Co.
1639 So. Broad St., Philadelphia, Pa. — *William Ranieri*

H. E. Williams Products Co.
108 S. Main St., Carthage, Mo. — *F. B. Williams, Jr.*

Wilmot Castle Co.
1255 University Ave., Rochester 7, N. Y. — *E. H. Greppin*

J. A. Wilson Lighting & Display Ltd.
9 Morrison St., Toronto, Ont., Canada — *J. A. Wilson*

The Windsor Utilities Comm.
149 Chatham St., W., Windsor, Ont., Canada — *W. A. Shaw*

The Wiremold Co.
Hartford 10, Conn. — *D. Hayes Murphy*

Wisconsin Electric Power Co.
Public Service Bldg., Milwaukee 1, Wis. — *G. W. Van Derzee*

Wisconsin Gas & Elec. Co.
100 Third St., Racine, Wis. — *J. H. Dunham*

Wisconsin Power & Light Co.
122 W. Washington Ave., Madison 1, Wis. — *J. D. Howard*

Wisconsin Public Service Corp.
Green Bay, Wis. — *A. G. Bur*

Worcester County Electric Co.
11 Foster St., Worcester, Mass. — *Fred E. Littlefield*

The Yonkers Electric Light & Power Co.
9 South 1st Ave., Mt. Vernon, N. Y.

? ? ? ? YB IN DARK ? ? ? ?

To best solve today's and tomorrow's Planned Lighting problems you need, NEW Light on Planned Lighting. **Attend the THIRD INTERNATIONAL LIGHTING EXPOSITION and CONFERENCE.** There will be outstanding exhibits by leading lighting equipment manufacturers... new developments and designs... more Merit Award Winning Case Studies... and still better conferences than those that enthused and inspired over 15,000 visitors at the First and Second Lighting Expositions.

Come to see the latest advances in Planned Lighting for all lines of Business, Industry, Schools, Theaters, Service Stations, Airports, Play Areas, etc.—to hear lighting authorities reveal the latest developments in Illumination Technique, Lighting Trends and Progress, Selling Plans, Installation and Maintenance Methods; Benefit by Round-table Comment; meet men who have the same Planned Lighting problems as you—and learn how they are solving them!

★ **plan now to attend** *interesting events every day*

★ **enter merit award competition**

Are you an Architect, Electrical Contractor, Electrical Wholesaler or Salesman, Utility Representative or Engineer, or an Owner or User of Industrial or Commercial Lighting? Then you are eligible to enter the $1500 Merit Award Competition for the best Case Studies describing and picturing outstanding Planned Lighting in which you have had a part. Achieve one of the recognized honors conferred by the Lighting Industry and perhaps win one of the 15 Gold Seal Cash Prizes of $100 each.

$1500.00

in gold seal **cash prizes**

★

Check Coupon below for Application Blank and Rules Booklet

★

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION NEMA MEMBER

NO WAITING IN LINE *if* you mail in this COUPON

THE THIRD INTERNATIONAL LIGHTING EXPOSITION is sponsored as a public service by the Industrial and Commercial Lighting Equipment Section of the NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

"Early Bird" APPLICATION FOR FREE ADVANCE REGISTRATION

TO THE **THIRD INTERNATIONAL LIGHTING EXPOSITION MANAGEMENT** • 111 WEST JACKSON BLVD., CHICAGO, ILL.

Without obligation, I wish to apply for free Advance Registration at the THIRD INTERNATIONAL LIGHTING EXPOSITION and CONFERENCE.

My badge of admission to Exhibit Hall is to be ready for me when I call for it at the Registration desk and there will be no waiting.

NAME .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

COMPANY .....

MY POSITION IS .....

☐ Check here if you want the Merit Award Competition Application Blank and new Official Rules Booklet

8-2773-R

PORT OF N. Y. AUTHORITY · DU MONT LABORATORIES · BAKELITE · PHILADELPHIA ELECTRIC · WESTERN ELECTRIC · GENERAL MOTORS · DOW-CORNING · WRIGHT AERONAUTICAL · LINK BELT · and thousands of others have switched!

COLONIAL COLD CATHODE APPEALS TO ENGINEERS WHO NEED *THE BEST*...

BECAUSE ... it offers 2500 lumens per 8-ft. lamp — over 59 lumens per watt.

BECAUSE ... it means long lamp life — 15,000 hours of efficient life expectancy — 70% of initial (100 hour value) lumens at 8,000 hours!

BECAUSE ... it is Underwriters' Approved, union made and *guaranteed for one year.*

Yes sir! IT WILL PAY YOU TO INVESTIGATE THIS NEWEST APPROACH TO PERMANENT LIGHTING!

COLONIAL ELECTRIC PRODUCTS, INC.
Foremost Developers and Producers Engineered Cold Cathode Lighting
EAST PATERSON, NEW JERSEY

ORIGINAL SOLID CORRUGATED

WIRE GLASS

Unexcelled for providing adequate, pleasantly diffused daylighting at low maintenance cost

in

ROOFS SIDEWALLS SKYLIGHTS
MARQUISES CANOPIES

Manufactured by

PENNSYLVANIA WIRE GLASS COMPANY
1612 MARKET STREET PHILADELPHIA 3, PA.

Get the Facts....
About Lighting Theory, Practice and Procedure in the

I. E. S. LIGHTING HANDBOOK

Now in its third printing since publication in 1947, this manual has proved invaluable as a reference work to men and women in all phases of lighting. Prepared and edited by leading authorities in the field, the Handbook's 850 pages are packed with information devoted to the latest in illumination, carefully indexed.

For Easy Ordering Use Coupon on Page 10A

ILLUMINATING ENGINEERING SOCIETY
51 MADISON AVENUE NEW YORK 10, N. Y.

MULTI

Welcomes the opportunity of greeting the Illuminating Engineering fraternity through its official organ

Lighting Equipment Is Our Business

R.L.M. Industrial Fixtures
Porcelain Enamelled Diffusers
Vaporproof and Outdoor Units
Commercial Fluorescent Fixtures
Floodlights and Centralized Lighting
Wiring Devices and Specialties

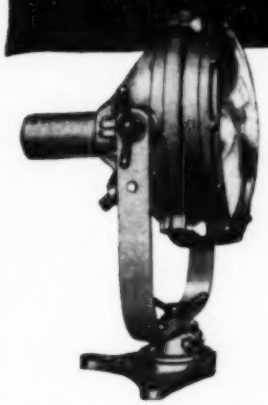
Distributed through leading jobbers

MULTI ELECTRICAL MFG. COMPANY
4223-43 WEST LAKE ST. CHICAGO 24, ILL.

DEPENDABLE

Floodlighting

WITH MINIMUM MAINTENANCE



Pyle-National heavy duty floodlight equipment is built to withstand severe operating conditions; to provide the reliable lighting needed for protection, and for outdoor night work. Pyle-National reflector design and light control lenses assure high efficiency lighting with proper distribution for maximum usefulness. The wide range of types and sizes, from 100 watts to 2000 watts, allows individual requirements to be met easily and economically—substantial weatherproof construction with sealed interior gives maximum protection to reflector and lamp bulbs. Interior cleaning and other maintenance is greatly reduced. Write for Catalog 2100 giving full information, with beam efficiency, candlepower, and light distribution data.

THE PYLE-NATIONAL COMPANY

1330 N. Kostner Avenue, Chicago 51, Illinois

THE MOST COMPREHENSIVE LINE in the WORLD

HUNDREDS OF TYPES TO CHOOSE FROM

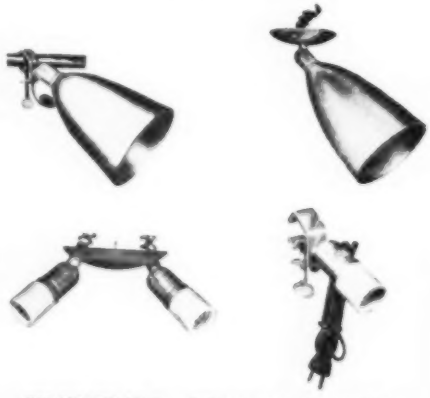
Universally Adjustable

SWIVELIER LIGHTING FIXTURES

The BEST in the WORLD—

BECAUSE OF THE PATENTED SPRING TENSION

SWIVELIER SOCKET!



SWIVELIER COMPANY, INC.

30 IRVING PLACE, N. Y. 3, N. Y.

This BETTER FLUORESCENT LIGHTING PERFORMANCE IS VISIBLE TO THE EYE

It's possible to pick out Acme Electric fluorescent ballast equipped fixtures in service by noticing these important performance features. First—all lamps of multiple lamp fixtures light up at the same instant as a result of full rated watt output. Second—no flicker in operation because secondary voltage exactly complies to lamp operating voltage. Third—noise-free because cores have no loose laminations, are thoroughly impregnated and sealed in compound. These are a few of the important features of Acme Electric ballasts that assure better performance, and longer service to fluorescent lamps.

ACME ELECTRIC CORPORATION

291 Water St. Cuba, N. Y.

Acme ACME Electric

LIGHTING DESIGN

by

PARRY MOON

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

and

DOMINA EBERLE SPENCER

BROWN UNIVERSITY

HERE IS . . . a textbook on lighting which presents fundamental principles in a quantitative manner. A comprehensive design method for practicing engineers in devising high-quality lighting systems for rooms.

PROPER LIGHTING is of such vast importance to the human race that there is no excuse for continuing the haphazard design methods of the past. Tried and tested at the Massachusetts Institute of Technology and at Tufts College, this book is of vital interest to practicing architects and engineers and to students.

Order Today and . . .

Send for catalog listing other technical publications

CONTENTS: Fundamentals; Lamps and Luminaires; Reflecting and Transmitting Media; Calculation of Pharosage and Helios; Interflections; Helios; Maintenance; Vision; Eight Factors in Lighting Design; Color; Symbols; Conversion Factors; Pharosage, Circular and Rectangular Sources; Fundamental Interflection Equations.

App. 500 pp., 100 illustrations
6"x9", cloth bound per copy $5.00

ADDISON-WESLEY PRESS INC.

KENDALL SQ., CAMBRIDGE 42, MASS., U.S.A.

INDEX OF ADVERTISERS

January, 1949

Acme Electric Corp.	36A
Addison-Wesley Press Inc.	36A
Benjamin Electric Mfg. Corp.	Inside Front Cover
Certified Ballast Mfrs.	Inside Back Cover
Chatfield-Clarke Co.	26A
Colonial Electric Products, Inc.	34A
Curtis Lighting Inc.	8A
Electro Mfg. Co.	28A
Ender Mfg. Co.	24A
Fleur-O-Lier Mfgrs.	4A-5A
Frink Corp.	21A
Garden City Pltg. & Mfg. Co.	29A
General Electric Co., Const. Mat'ls.	19A
General Electric Co., Lamps	12A-13A
Gill Glass & Fixture Co.	30A
Edwin F. Guth Co.	27A
Holdenline Co.	37A
Internat'l Lighting Exposition	33A
Leader Electric Mfg. Co.	16A
Lighting Products Inc.	18A
Miller Company	23A
Multi Electrical Mfg. Co.	34A
N.E.M.A.	6A-7A
Pa. Wire Glass Co.	31A
Phila. Electrical & Mfg. Co.	20A
Pyle-National Co.	35A
R.L.M. Standards Institute	38A
Rambusch Decorating Co.	15A
L. J. Segil Co.	14A
Silvray Lighting Inc.	17A
Smoot-Holman Co.	35A
Solar Light Mfg. Co.	25A
Steber Mfg. Co.	32A
Sterling Reflector & Mfg. Co.	28A
Swivelier Co. Inc.	36A
Sylvania Electric Products, Inc.	11A
Thompson Electric Co.	22A
F. W. Wakefield Brass Co.	9A
Westinghouse Electric Corp., Lamps	Back Cover
Westinghouse Electric Corp., Lighting	1A
Wheeler Reflector Co.	31A

What's Wrong

with my brightness ratio?

Wait-a-minute, Lady! We're talking about *lighting* comfort —not mental comfort. All we said was that brightness ratios *in your office* could be improved. And the same goes for stores, schools and hospitals.

Look at ordinary fluorescent fixtures. You'll see eye-tiring brightness contrasts all along the surface. Some parts are dark . . . some are sharply bright. This common variation in light intensity is caused by the heretofore necessary use of unlike materials in the louver, such as metal and glass . . . or metal and plastic.

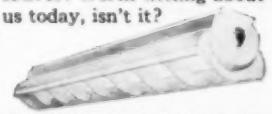
Today, however, objectionable brightness contrast has *at last been eliminated*. Now there's a new, higher standard for fluorescent lighting.

The Holdenline Arrowhead louver is *all-plastic*, with no metal restraining parts. Brightness is uniform on all sides and sections. Without dark-to-bright contrasts, this advanced louver is equally attractive whether operating or unlighted.

Holdenline Arrowhead design diffuses light evenly, softly. It reduces glare and prevents ugly bright spots on walls and ceilings.

No bug graveyard, the Arrowhead louver is shaped to prevent dirt accumulation. And for strength, self-locking plastic parts are all bonded into an integral unit that can't warp, sag, expand or discolor under any normal operating conditions. An Arrowhead louver snaps into place in a jiffy without screws.

For comfort and efficiency, there's nothing under the sun like good lighting. Be sure to see the years-ahead Arrowhead fluorescent fixture before you develop relighting or expansion plans. *It features the only all-plastic, controlled brightness louver*. Worth writing about to us today, isn't it?



HOLDENLINE ARROWHEAD FIXTURE—Catalog No. CP-240. Ballast enclosed in Chan'l-Run Basic Unit. Pat. pending.

HOLDENLINE CHAN'L-RUN SERVES INDUSTRY TOO

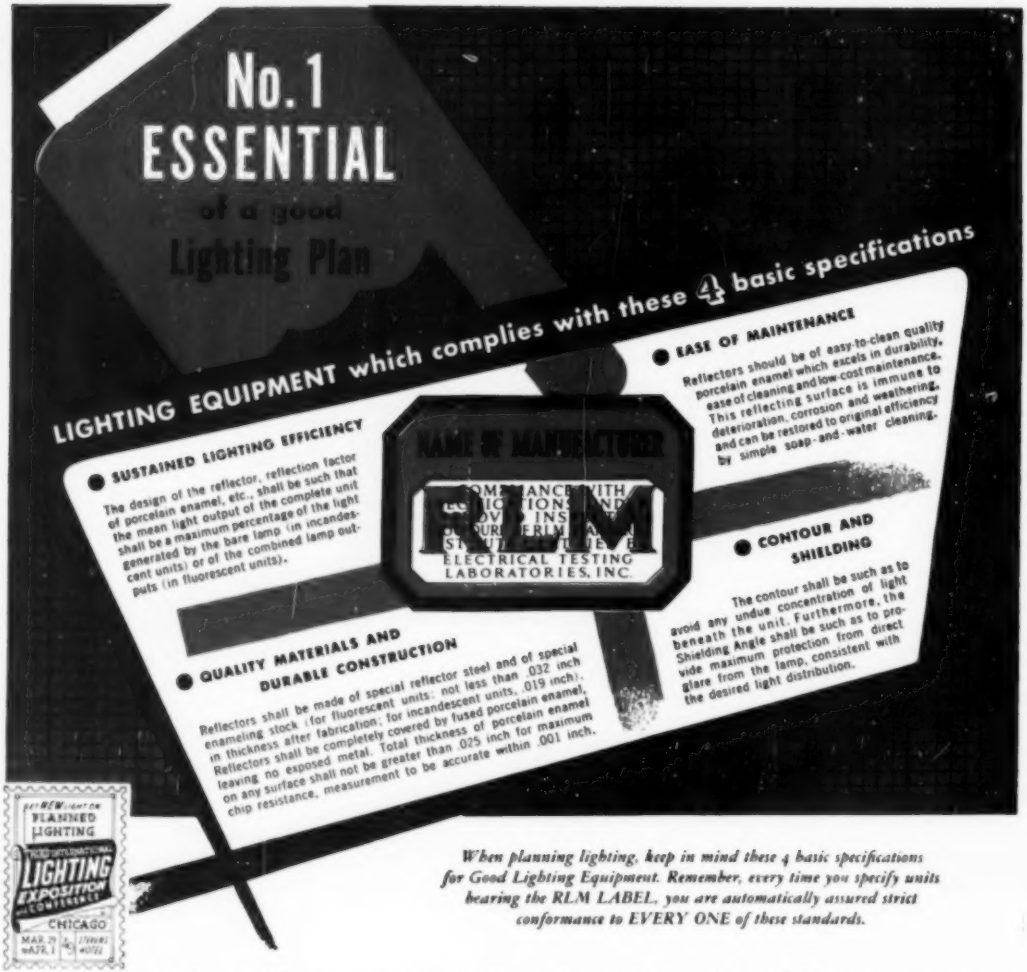
Individual or continuous runs with standardized heavy-gauge units. Sockets mounted on welded end plate for positive, safe lamp spacing. End plate protects sockets during relamping.

HOLDENLINE CO.

Pioneers In Fluorescent

2287 Scranton Road • Cleveland 13, Ohio

HOLDENLINE—T. M. REG. U. S. PAT. OFF. 1937


No. 1
ESSENTIAL
of a good
Lighting Plan
LIGHTING EQUIPMENT which complies with these 4 basic specifications
SUSTAINED LIGHTING EFFICIENCY
The design of the reflector, reflection factor of porcelain enamel, etc., shall be such that the mean light output of the complete unit shall be a maximum percentage of the light generated by the bare lamp (in incandescent units) or of the combined lamp outputs (in fluorescent units).
EASE OF MAINTENANCE
Reflectors should be of easy-to-clean quality porcelain enamel which excels in durability, ease of cleaning and low cost maintenance. This reflecting surface is immune to deterioration, corrosion and weathering, and can be restored to original efficiency by simple soap-and-water cleaning.
NAME OF MANUFACTURER
RLM
ELECTRICAL TESTING LABORATORIES, INC.
QUALITY MATERIALS AND DURABLE CONSTRUCTION
Reflectors shall be made of special reflector steel and of special enameling stock (for fluorescent units; not less than .032 inch in thickness after fabrication; for incandescent units, .019 inch). Reflectors shall be completely covered by fused porcelain enamel, leaving no exposed metal. Total thickness of porcelain enamel on any surface shall not be greater than .025 inch for maximum chip resistance, measurement to be accurate within .001 inch.
CONTOUR AND SHIELDING
The contour shall be such as to avoid any undue concentration of light beneath the unit. Furthermore, the Shielding Angle shall be such as to provide maximum protection from direct glare from the lamp, consistent with the desired light distribution.
PLANNED LIGHTING
LIGHTING EXPOSITION
CHICAGO

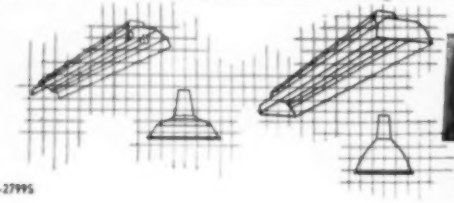
When planning lighting, keep in mind these 4 basic specifications for Good Lighting Equipment. Remember, every time you specify units bearing the RLM LABEL, you are automatically assured strict conformance to EVERY ONE of these standards.

What is "A Good Industrial Lighting Plan?" A *Good* Lighting Plan is one that provides the right quantity and quality of illumination for the seeing task with a minimum of direct and reflected glare and at the lowest possible "year-in and year-out" operating and maintenance costs.

Good Lighting Equipment is Basic to Good Planning. Even with the most careful planning of footcandle levels, light distribution, reflection factors, etc., YOUR LIGHTING PLAN WILL FAIL unless you insist on lighting equipment which meets the four basic specifications of good lighting equipment.

The RLM LABEL ASSURES YOU continuous compliance with these 4 specifications, as well as 5 other standard specifications. Conformance and uniform quality of each certified unit is determined through strict, periodical inspections by the Electrical Testing Laboratories, Inc., N. Y. Once this organization authorizes affixing of the RLM LABEL to a lighting unit, the label becomes a warrantee certificate. It guarantees that you can buy, sell, specify or install that unit with complete confidence . . . no need for further checking or verification on your part.

For **Free Booklet** containing standard specifications established for 14 different fluorescent and incandescent lighting units, as well as a list of the manufacturers making them, write to RLM Standards Institute, Suite 823 326 W. Madison St., Chicago 6, Ill.



RLM STANDARDS INSTITUTE
INCORPORATED
The letters RLM stand for Reflector and Lighting Equipment Manufacturers

R-27995

for better fluorescent lighting

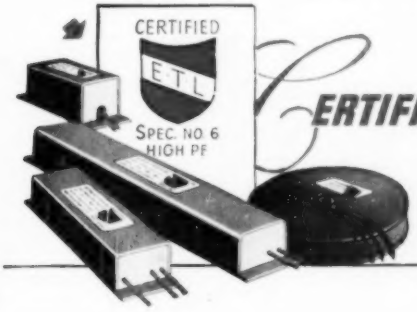
DEMAND *Certified Ballasts*

• When you demand and insist on Certified Ballasts in fluorescent lighting fixtures—you're protecting your own best interests—as well as the users'.

Everyone benefits by using Certified Ballasts because they assure . . .

Full lamp life — **Rated light output**
Quiet operation — **Dependable performance for fixture life**

Strict specifications control the building of every Certified Ballast—Electrical Testing Laboratories, Inc., an impartial judge, then checks and tests them. You're surer of satisfaction with Certified Ballasts.



CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

2116 KEITH BLDG., CLEVELAND 15, OHIO

NEW Westinghouse 85-WATT FLUORESCENT LAMP EQUALS OUTPUT OF 100-WATT LAMP

USE OF KRYPTON GAS INCREASES EFFICIENCY 17%; NEW LAMP OPERATES IN PRESENT 100-WATT FIXTURES

This new Westinghouse lamp produces 49.5 lumens per watt, as compared with 42 lumens per watt for the 100-watt lamp which it replaces. The new unit has an average life of 6,500 hours at 12 hours per start.

The 85-watt fluorescent lamp is five feet long, 2⅛ inches in diameter, and offered in five hues of white light—daylight, 4500 degree white, standard white, soft white, and the new warm white. For more information about this new money-saving lamp, call your Westinghouse Lamp Distributor or write to Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey.

YOU CAN BE SURE... IF IT'S Westinghouse
the name you know in LAMPS